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Project Summary Report for Pilot-Scale Demonstration of Red Water Treatment by Wet Air Oxidation and Circulating Bed Combustion

October 1995
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Task Order No. 0005

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FINAL

PROJECT SUMMARY REPORT

FOR

PILOT SCALE DEMONSTRATION OF RED WATER TREATMENT BY WET AIR OXIDATION AND CIRCULATING BED COMBUSTION

VOLUME 1 OF 4

USAEC Contract No. DACA 31-91-D-0074
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As part of the Army's ongoing research and development program related to red water (K047) treatment, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives included development of a Test Plan and a Health and Safety Plan for these demonstrations. The Project Summary Report presents the conceptual designs. This Project Summary Report and the Test Plan and Health and Safety Plan are intended to serve as guides for development of complete project plans when the technology demonstration program is implemented. Because red water is not currently available for testing and the test site (host facility) where the demonstrations will be conducted has not been identified, these documents are intended to be generic in nature.

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Preface

As part of the U.S. Army's ongoing program related to the research and development of red water treatment technologies, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot-scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives also included development of a Test Plan and Health and Safety Plan for these demonstrations, and preparation of a Project Report. This Project Report is intended to summarize the conceptual designs, Test Plan, and Health and Safety Plan and to serve as a guide for activities when the next phase of this program (i.e., conducting the demonstrations) is implemented.

Red water is not currently generated by the U.S. Army or any other part of the U.S. Department of Defense nor has it been generated in the recent past. An accurate and complete database does not exist in regard to the chemical and physical nature of red water. Due to this lack of waste characterization data, it was not possible to complete an accurate analysis of the associated testing and treatment requirements. Additionally, the source of red water for testing and the location where the tests will be conducted (i.e., the host facility) have not been identified. Therefore, waste- and site-specific concerns and requirements cannot be accurately or completely addressed at this time. As a result, this phase of the investigation included completion of plans and conceptual designs. Completion of system designs and finalization of test and safety plans must be completed in the future prior to initiation of the demonstration program.

This Project Report outlines the current project status and identifies the steps which must be completed prior to conducting the demonstrations. These include: selecting a host facility, obtaining red water for the demonstrations, characterizing the red water, preparing final process and equipment designs, finalizing Health and Safety and Test Plans, and acquiring the test equipment. Because of the unique and largely undocumented nature of red water, once a source has been identified, a critical initial objective will be characterization of the physical and chemical nature of the waste and a review of the associated treatment requirements.

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1.0 Introduction

Production of trinitrotoluene (TNT), the major component of most of the Department of Defense explosives, generates a wastewater stream called red water. Because of its reactivity, red water has been listed as a hazardous waste (K047) by the U.S. Environmental Protection Agency (U.S. EPA) under Subtitle C, Part 265 of the Resource Conservation and Recovery Act (RCRA). Four Army Ammunition Plants (AAPs)--Radford, Joliet, Newport and Volunteer -- have the production facilities necessary for the manufacture of TNT. However, these facilities are currently idle and in mothballed status. None of these facilities have been used to produce TNT in recent years because the military's peace-time requirement has not been sufficient to justify the cost of their operation. Additionally, none of the AAPs currently have the necessary regulatory/environmental permits or facilities to treat or dispose of red water.

Demonstration of an acceptable waste treatment technology is an important aspect in increasing the readiness of the Army to mobilize TNT production capability. It is anticipated that at some future time, the U.S. Army Environmental Center (USAEC) will conduct a pilot-scale demonstration of two or more technologies to evaluate potential methods for treating red water. Previously, a comparative evaluation of 30 potentially applicable technologies was completed by the USAEC (PEI, 1990). Two technologies, circulating bed combustion (CBC) and wet air oxidation (WAO), were concluded to be applicable for treating red water and to be sufficiently advanced to warrant pilot-scale testing. Preparations for the demonstration of these two technologies is the subject of this Project Report.

Because red water is not currently available for testing and because a host facility has not been selected for the technology demonstrations, preparation for the demonstrations at this time is restricted to completion of conceptual designs and plans. This Project Report and the supporting documents listed below provide the conceptual plans for a demonstration of WAO and CBC and are intended to serve as a starting point for the next phase of activities (i.e., implementation of testing).

- Regulatory Review Evaluation (Appendix A)
- WAO Conceptual Design Report (Appendix B)
- CBC Conceptual Design Report (Appendix C)

- Health and Safety Plan (under separate cover)
- Test Plan (under separate cover).

1.1 Background

The U.S. Army has conducted two evaluations to identify technologies applicable to the treatment of red water. The earliest study was conducted by the U.S. Army Chemical Systems Laboratory and was completed in April 1980 (CSL, 1980). Subsequently, a study was completed in 1990 by the USAEC to update and expand the previous effort (PEI, 1990). The latter report presents an evaluation of waste treatment technologies that are potentially applicable for treatment of red water based on technical, economical, and environmental considerations and included those addressed in the earlier CSL report. Two of the technologies evaluated, WAO and CBC, were determined to be sufficiently advanced to warrant pilot-scale demonstration. However, the demonstrations have not been initiated because red water is not currently generated by AAPs and an alternate source of red water for the pilot-scale demonstrations has not been identified.

Most recently, the USAEC conducted an evaluation to identify the most viable options for obtaining the volume of red water (approximately 50,000 gallons) necessary for the pilot-scale demonstrations (IT 1993). The following six options were identified and evaluated:

- Synthesize a surrogate red water
- Restart TNT production at an AAP to generate red water
- Construct and operate a TNT production pilot plant to generate red water
- Obtain red water from the current supplier of the Army's TNT (i.e., ICI Explosives Canada)
- Obtain red water from a foreign TNT producer
- Conduct the demonstrations at an operating TNT production facility (e.g., ICI Explosives Canada).

The results of this evaluation indicated that the most viable option appeared to be conducting the tests at an operating TNT production facility. This option avoids the need to transport large quantities of red water and would benefit from the generator's familiarity with this waste. The evaluation resulted in a ranking of the six options but did not include negotiations with TNT

suppliers to determine the actual viability of this option or to secure the use of their facilities or to acquire red water.

In order to further advance the red water treatment technology evaluation, the USAEC issued the current Task Order to IT Corporation for the preparation of conceptual plans and designs necessary for the demonstrations. During the initiation of this Task Order, it was determined that no transportable or fixed base, pilot-scale WAO and CBC demonstration units existed that were capable of meeting the USAEC's required throughput rates and operating temperatures and pressures. Therefore, conceptual design of the demonstration units became necessary. The current effort was restricted to the completion of conceptual engineering designs (i.e., 10 percent designs) because data on the composition and characteristics of red water are incomplete, a source of red water for testing has not been secured, and the location where the demonstrations will be conducted has not been determined.

1.2 Scope and Objectives

The scope of this project included completion of conceptual designs for transportable, pilot-scale WAO and CBC demonstration units and the preparation of health and safety plans, test plans, and a review of applicable regulations. The results of these efforts are summarized in this project report. These documents were prepared by IT Corporation under USAEC Contract No. DACA 31-91-D-0074, Task Order No. 5. This summary report documents the conceptual design process and describes the requirements for planning and conducting the demonstrations. The Test Plan (prepared in accordance with IAW DD Form 1423, Sequence A002, and provided under separate cover) discusses the procedures for performing the demonstrations and evaluating the results based on currently available information and best engineering judgment. A Health and Safety Plan was prepared in accordance with IAW DD Form 1423, Sequence A003, and was also based on available information.

The primary objective of these documents is to describe the initial phase of preparation for a demonstration of red water treatment including the vendor selection and conceptual design for WAO and CBC pilot-scale systems, and to provide an implementation plan for the demonstrations. The scope of work did not include site selection, acquisition of red water, completion of equipment design or acquisition of the equipment, or actual conduct of the demonstrations.

1.3 Project Schedule

The schedule for acquiring red water and for conducting the WAO and CBC demonstrations has not been defined. The schedule for the demonstration depends on the ability of the Army to obtain red water and to obtain access to a demonstration site (including completion of any necessary permit requirements, which alone could take a year or more). This Project Report and associated plans are intended to advance the planning activities to a logical break point (i.e., completion of conceptual design) and to provide documentation that will permit project activities to resume when red water and a host facility become available.

2.0 Regulatory Review

All USAEC demonstrations must be conducted in a manner that complies with all applicable Federal, state, and local laws. To ensure compliance, a regulatory review must first be conducted to identify applicable regulations, restrictions, and permitting requirements. Regulations and requirements that potentially would be applicable to the pilot-scale demonstration of WAO and CBC technologies were reviewed as part of this Task Order. In addition to reviewing regulatory requirements for the pilot-scale demonstrations, the regulatory review also included a preliminary determination of regulations and requirements potentially applicable to full-scale implementation of these technologies for treatment of K047. This aspect was considered to help formulate the goals of the treatment demonstrations (i.e., how to determine if adequate treatment was achieved). A summary of the regulatory review is provided in this section. Additional details are provided in a separate project report entitled "Regulatory Overview for Pilot-Scale Demonstration and Full-Scale Treatment of Red Water (K047)," which is presented in Appendix A and is hereinafter referred to as the "Regulatory Review Report."

Because the location for the demonstrations has not been selected, the regulatory review was necessarily generic in regard to state and local requirements. To facilitate the process, it was assumed that the demonstrations will be conducted within the United States. Further, it was assumed that Radford AAP (RAAP) (Radford, Virginia) is the AAP most likely to resume TNT production in the future. Therefore, regulatory issues specific to Virginia were addressed as appropriate. This assumption regarding RAAP was made by the project team for the purpose of facilitating the regulatory review and was not based on knowledge of Army policy or mobilization plans regarding the future operations of specific AAP's. If it is determined that the demonstrations will be conducted at another facility or at a location outside of the United States, the regulatory review will have to be expanded (e.g., to address international regulations).

The regulatory review included consideration of five major Federal environmental statutes: the Resource Conservation and Recovery Act (RCRA), the Hazardous Materials Transportation Act, the Clean Water Act (CWA), the Clear Air Act (CAA), and the Occupational Safety and Health Act. These laws and the rules, regulations, and guidances issued under them, specify the restrictions and practices applicable to pilot-scale demonstration of hazardous waste treatment technologies. Transportation, storage, handling, treatment, and disposal of hazardous waste, as

well as disposal of residuals from treatment, are covered by RCRA, which is administered by the U.S. EPA or the State (in cases where the state has been granted primacy), and the Hazardous Materials Transportation Act, which is administered by the Department of Transportation (DOT). Discharges of effluents and residuals to air and water are regulated under the RCRA, CAA, and CWA. Employee protection, for personnel involved in handling hazardous materials and in conducting a demonstration involving hazardous waste or hazardous materials, is regulated by the Occupational Safety and Health Administration (OSHA).

The results of the review, presented in this section, are organized according to these major laws. General RCRA facility requirements are discussed in Section 2.1, regulation of liquid effluents are covered in Section 2.2, air emissions are addressed in Section 2.3, and disposal of solid residuals is covered in Section 2.4.

2.1 RCRA Facility Requirements

Red water is listed in 40 CFR 261.32 as a hazardous waste from a specific source (pink/red water from TNT operations) and has been assigned the EPA hazardous waste number K047. Reactivity of the waste was the basis for this listing. In addition to the untreated waste itself, residuals generated from the treatment, storage, or disposal of the waste will retain the K047 listing and by definition be a RCRA hazardous waste per the "derived from" rule (40 CFR 261.3(b) and (c)). Therefore, any residuals from the demonstration of WAO or CBC technologies must be managed as listed hazardous wastes. In addition to its listing, untreated K047 or residuals of the treatment demonstration may exhibit other RCRA hazardous characteristics. For example, they may be ignitable (D001), corrosive (D002), or exhibit RCRA toxicity characteristics as determined by the RCRA Toxicity Characteristic Leaching Procedure (TCLP) (D004 - D043). For example, the waste may exceed the regulatory limit for 2,4-dinitrotoluene (D030). These characteristics must be determined by testing and analysis of the specific wastes and residuals. These characteristics will determine how the materials can be disposed of.

RCRA regulations will apply to all phases of the demonstration from acquisition of the red water for testing through disposal of any and all project residuals. Significant administrative requirements, including permits, manifesting during transportation, training requirements, etc., will be associated with a demonstration involving the quantities of red water envisioned for these demonstrations (~50,000 gallons).

The test (host) facility must have the appropriate RCRA permits and approvals prior to receipt of the red water. Two scenarios may be encountered in regard to the RCRA permitting of these demonstrations:

- The tests may be conducted at a facility that has an existing RCRA Part B or RCRA Research, Demonstration, and Development (RD&D) permit.

- The tests may be conducted at a facility that must obtain a RCRA Part B or RCRA RD&D permit.

Conducting the demonstrations under the RCRA treatability exclusion is not an option. The treatability exclusion rule (40 CFR 261.4 (3) and (f)) allows for the shipment and testing of up to 10,000 kg of hazardous waste (~2,500 gallons of red water) without the need to comply with RCRA manifesting or facility permitting requirements. Under this exclusion, however, the host facility must have an EPA Hazardous Waste Generator ID number and any residuals would have to be disposed of as hazardous waste. Additionally, testing of nonbiological technologies must be completed within one year under the exclusion. Unless the planned demonstrations can be reduced in scope so that they can be conducted with less than 10,000 kg of red water, the treatability exclusion would not apply and the demonstration must be conducted under one of the two scenarios identified above.

In terms of program timelines and project schedules, obtaining a RCRA Part B permit would be expected to take a minimum of two years. Obtaining a RCRA RD&D permit would be anticipated to take at least 9 to 12 months. Modification of an existing RCRA Part B permit would likely take at least a similar length of time. Because of the relatively short term of the test program and the limited number of technologies included, obtaining a RCRA RD&D permit is anticipated to be the most viable option. A RCRA RD&D permit application typically resembles a RCRA Part B application, but on a smaller scale. Information would be required on the facility, waste characterization, process descriptions, procedures to prevent hazards, contingency plans, personnel training, and a closure plan.

As with all other aspects of the demonstration, once the source and characteristics of red water are known and candidate host facilities have been identified, the project team can approach the appropriate RCRA regulators (the U.S. EPA or the state in cases where the state has been granted RCRA primacy) to discuss specifics of the program and define actual facility permit requirements.

2.2 Liquid Effluents

Treatment of red water by WAO will result in generation of a liquid effluent. Treatment by CBC is not anticipated to result in liquid effluents. The WAO effluent, depending upon its characteristics, may potentially be disposed of in one of three ways. The selection of the most appropriate method will be determined by site- and waste-specific regulatory and logistical concerns. The three options are:

- Disposal as a hazardous waste at a RCRA-permitted treatment, storage, and disposal facility (TSDF)
- Discharge to a publicly-owned treatment works (POTW)
- Discharge to a body of water under the National Pollutant Discharge Elimination System (NPDES).

Each of these options would require compliance with specific treatment standards, analysis of the effluent for regulated parameters and constituents, and submittal of regulatory compliance documentation. Shipment of the effluent to a RCRA-permitted TSDF would require the least treatment by the generator, whereas discharge to a body of water via an NPDES outfall would require the greatest degree of treatment. More specific regulatory considerations for each option are outlined in the following sections.

2.2.1 TSDF Disposal of WAO Effluent

Currently, it is anticipated that project residual effluents will be disposed of at a RCRA TSDF. The acceptability of the WAO effluent for treatment by a RCRA-permitted TSDF will depend on the permit limitations of the TSDF in treating K047 waste. Because red water is a RCRA-listed hazardous waste, residuals of any treatment process will retain the classification of a RCRA hazardous waste (the "derived from" rule at 40 CFR 261.3(c)), unless formally delisted in accordance with 40 CFR 260.22. As discussed in Section 3.1 of the Regulatory Review Report (Appendix A), it is anticipated that delisting of demonstration residuals will not be a viable option.

The RCRA also defines land disposal restriction (LDR) treatment standards for listed hazardous wastes. The LDR standard for K047 is specified as deactivation in 40 CFR 268.40. Deactivation, as defined in Table 1 of 40 CFR 268.42(a)(3), is treatment to remove the hazardous characteristic

of reactivity. Appendix VI to 40 CFR 268 includes a listing of recommended technologies to achieve deactivation. The recommended technologies for nonwastewater include chemical oxidation, chemical reduction, and incineration. The recommended technologies for wastewater include chemical oxidation, chemical reduction, biodegradation, carbon adsorption, and incineration. These technologies are not mandatory and other methods of treatment may be used if they achieve deactivation. However, deactivated K047 residues would still retain the K047 hazardous waste listing. They could be landfilled at a RCRA Subtitle C (hazardous) landfill if the residue meets the landfill-specific disposal requirements (or can be treated to meet the requirements) and if the landfill is permitted to manage K047 waste.

To gain acceptance for disposal of WAO liquid effluents at a TSDF that is permitted to accept K047, the waste must be fully characterized and a sample of the waste must be submitted to the TSDF along with a completed waste profile form. It is anticipated that the physical and chemical characterization of the effluent would include testing to determine its specific gravity, pH, ignitability (D001), reactivity (D002), and RCRA toxicity characteristic leaching procedure (TCLP) results (D004 - D043) as well as to determine the concentrations of numerous specific constituents such as cyanide, sulfide, phenolics, polychlorinated biphenyls, oil and grease, total organic carbon, and total organic halogen. If the waste conforms with the capabilities and permit restrictions of the TSDF, it can then be approved for receipt and treatment. At least four RCRA TSDFs are believed to be capable of accepting red water for treatment: Chemical Waste Management in Port Allen, TX; Trade Waste Incineration in Sauget, IL; Essex Waste Management in Kingsville, MO; and ICI Explosives in Joplin, MO. Chemical Waste Management and Trade Waste Incineration cannot accept the residuals unless they are classified as DOT Hazard Class 1.1 or 1.2 (explosive). Essex can accept bulk or drummed waste. ICI Explosives cannot treat free liquids; these liquids must be absorbed on sawdust or polymeric resin prior to treatment. (Information on these TSDFs is preliminary and based on currently available information.) All of these TSDFs use incineration technology except Essex, which uses deactivation. Once approved, the waste can be properly containerized, placarded, and transported under manifest by a RCRA-permitted transporter. After the waste has been received and treated or disposed of by the TSDF, a certificate of disposal would be issued to the generator confirming the final disposition of the material.

2.2.2 POTW Disposal of WAO Effluent

Another disposal option for demonstration residues may be discharge to a POTW. This option may be feasible depending upon the characteristics of the WAO effluent, the location of the host facility, and acceptance by the POTW. Discharge of the WAO effluent to a POTW, if excluded from RCRA under the specifications of 40 CFR 261.4(a)(2), would be subject to regulation under Section 402 of the CWA and if the host facility is located in Virginia, to the corresponding Commonwealth of Virginia regulations (VR 680-14-01). Part VII of VR 680-14-01 establishes the legal requirements for state and local governments and industry for implementation of National Pretreatment Standards (NPS) for the control of pollutants that pass through or interfere with treatment processes in POTWs or which may contaminate POTW sludge. Section 7.2 of VR 680-14-01 incorporates federal regulations regarding pretreatment standards including standards, removal credits, POTW pretreatment programs, guidelines for test procedures, variances from pretreatment standards, calculations, by-pass, modification to the POTW's program, and most of the National Categorical Pretreatment standards (NCPS). The federal categorical pretreatment standards for explosives manufacturing (40 CFR 457) are not incorporated in VR 680-14-01 by reference. The Virginia State Water Control Board is required by VR 689-14-01 Section 7.2(B) to adopt changes or modifications to the federal regulations or undertake a rule making to adopt more stringent control. Whether the Board eventually adopts the federal pretreatment standards for explosive manufacturing or adopts more stringent regulations, the WAO effluent, at a minimum, must meet the limitations established in 40 CFR 457.12 after the application of the best practical control technology currently available.

Other discharges prohibited by VR 680-14-01, Section 7.4, address the introduction of pollutants into a POTW that will:

- Pass through or interfere with the operation or performance of the POTW
- Create a fire or explosive hazard in the POTW
- Cause corrosive structural damage to the POTW
- Cause obstruction to the flow in the POTW
- Cause interference with the POTW (including oxygen demand)
- Result in inhibition of biological activity at the POTW due to heat.

The POTW is required by Section 7.4(B) of VR 68-14-01 to develop and enforce specific limits upon the industrial user. Typical analytical requirements that would be anticipated for approval of such a discharge to a POTW would include:

- Explosivity
- Reactivity
- Chemical oxygen demand (COD)
- Biochemical oxygen demand, 5-day (BOD_5)
- Total suspended solids (TSS)
- pH
- Other parameters to be determined by the POTW.

If the demonstrations are conducted at an AAP, a POTW may not be accessible because these facilities typically have industrial wastewater treatment plants that discharge to receiving bodies of water via NPDES permitted outfalls. If the demonstrations are conducted at a facility that discharges to a POTW, however, this may be an option.

2.2.3 NPDES Discharge of WAO Effluent

A third potential option for disposal of demonstration effluents could be discharge directly to a body of water via an NPDES-permitted outfall subject to regulation under Section 402 of the CWA or discharge to an on-site NPDES-permitted industrial wastewater treatment plant. Any discharge must be authorized by an NPDES permit per 40 CFR 401, or the Commonwealth of Virginia equivalent (VPDES) per VR 68-14-01, if the facility is in Virginia. Permit limitations are established on a facility-specific basis to ensure compliance with technology-based standards.

Typical analytical requirements that would be required in the permitting process would include testing for the characteristics of corrosivity, toxicity, and reactivity as well as quantification of state water quality criteria that may include metals, SVOCs, VOCs, pesticides, herbicides, ammonia, cyanide, hydrogen sulfide, and polychlorinated biphenyls. At this time it seems unlikely that state regulators would permit direct discharge to an NPDES outfall.

2.3 Air Emissions

Demonstration of both CBC and WAO technologies will result in air emissions. Because the emissions will result from the treatment of hazardous waste, they will be regulated and must be controlled. Potential emissions from the CBC demonstration were estimated during the conceptual design process (Table 1, Appendix A). The estimated emissions were based on preliminary material balances which are documented in the CBC Conceptual Design Report (Appendix C). Emissions from the CBC demonstration, which is an incineration technology, will be more significant in terms of volumetric flow rates, than emissions from the WAO demonstration.

State and federal air pollution control regulations under both the RCRA and Clean Air Act (CAA) programs are potentially applicable to the CBC demonstration and to a lesser degree, to the WAO demonstration. The CBC will generate combustion by-products that will be vented to the atmosphere through a stack after being treated in air pollution control equipment to remove regulated pollutants. Because CBC is considered incineration and red water is a RCRA-listed hazardous waste, the CBC must be permitted as a RCRA hazardous waste incinerator and comply with RCRA air emission criteria. The pilot-scale CBC demonstration unit must be permitted either as a Research, Demonstration, and Development (RD&D) facility or included under the RCRA permit of the host facility.

Requirements for a RCRA RD&D permit vary for each application and may not be as stringent as requirements for a non-RD&D permitted facility. As early as possible in the implementation phase, pre-permitting conferences should be held with the regulators to determine if an RD&D permit is applicable and to define the extent to which requirements for a RCRA-permitted incinerator will apply. RCRA incinerator regulations include both design standards and operational standards (including emission criteria that must be considered in the design).

The operation of the CBC must also comply with state and possibly federal air pollution control regulations. If the unit is sited at a location where it can be considered a stand-alone emission source, the state may require an air construction permit before the demonstration is implemented. If the unit is considered part of a larger facility (e.g., an AAP), the unit could be subject to a Prevention of Significant Deterioration (PSD) preconstruction permit modification and/or a CAA Title V operating permit. Again, detailed discussions with the regulators must be held early in the process to ensure that the demonstration meets permit requirements and that necessary permitting activities are conducted in compliance with applicable regulations. Although it is anticipated that the WAO will generate fewer total air emissions (including water vapor, carbon dioxide, nitrogen, oxygen, and other by-products) than the CBC, air permits will likely be required for this demonstration also. Although there are no WAO-specific RCRA requirements that pertain to air emissions, the reactions taking place in the WAO will generate off-gassing. General fugitive emissions requirements, however, could be applicable if the WAO unit is permitted under the RCRA requirements for other sources (40 CFR 264, Subpart X criteria). If the WAO unit is sited at a facility where it can be considered a stand-alone emission source, the state may require an air construction permit and operating permit. If the unit is considered part

of a larger facility (e.g., an AAP), the regulators could require a PSD preconstruction permit modification and/or a Title V operating permit. The sampling programs presented in Sections 5 and 6 of the Test Plan for the WAO and CBC demonstrations were prepared in consideration of these anticipated requirements.

2.4 Solid Residuals

Solid residuals (e.g., ash generated from treatment of a RCRA-listed hazardous waste by CBC technology) are, by definition, a RCRA hazardous waste. The generator must also determine if the ash is a RCRA characteristic waste per 40 CFR 261, Subpart C. The RCRA characteristics include ignitability (D001), corrosivity (D002), reactivity (D003), and toxicity characteristic (D004-D043). The regulatory limits for these classifications are listed in 40 CFR 261, Subpart C. The ash can be landfilled as a hazardous waste in a RCRA Subtitle C permitted hazardous waste landfill provided it meets the TSDF permit restrictions of the TSDF and the treatment standards presented in 40 CFR 268.

Prior to land disposal of CBC ash at a RCRA-permitted TSDF, the ash must meet the land disposal restrictions in 40 CFR 268 for a K047 waste, and any applicable RCRA characteristics. The land disposal restrictions for K047 as listed in 40 CFR 268.42 require deactivation to remove the hazardous characteristic of reactivity from the ash. This is a technology-based standard and does not specify a concentration limit. It is anticipated that the following parameters would have to be analyzed to meet the waste characterization and disposal criteria:

- Explosivity
- Reactivity
- TCLP
- Landfill parameters (e.g., specific gravity, pH, cyanide, sulfide, phenolics, polychlorinated biphenyls, percent water, percent solids, flash point, total petroleum hydrocarbons, and toxicity characteristic leaching procedure for metals, volatiles, semivolatiles, pesticides, and herbicides).

Unless delisted, any solid residuals from the demonstrations (e.g., CBC ash) must be transported to a TSDF as a hazardous waste. The generator must comply with the RCRA hazardous waste manifesting requirements (40 CFR 262) and DOT (49 CFR 171 to 199) hazardous materials

shipping requirements. Disposal of solid residuals at a RCRA-permitted TSDF is anticipated to be the most likely disposal option.

A second option for disposal of ash generated by a CBC system would be disposal in a nonhazardous waste landfill in accordance with RCRA Subtitle D requirements. Under this scenario, the ash generated from the CBC process would have to first be excluded from regulation as a RCRA hazardous waste (i.e., delisted). The delisting process defined in 40 CFR 260.20 and 260.22 requires the generator to demonstrate that the constituents for which the waste was listed and any other hazardous constituents (40 CFR 261, Appendix VIII) are not present at levels of regulatory concern and that the waste does not exhibit any of the characteristics of hazardous waste (i.e., ignitable, corrosive, reactive, or toxic). To demonstrate the nonhazardous nature of the waste, the generator must submit a delisting petition to the EPA, as outlined in "Petitions to Delist Hazardous Waste, a Guidance Manual" (EPA 530-R-43-007). EPA evaluates delisting petitions using an analytical approach to model transport of toxic constituents from a landfill. The RCRA delisting process may take 18 to 24 months to complete and typically is cost-effective only if significant volumes of waste are generated on a consistent basis. Therefore, delisting is not anticipated to be a viable option for the ash that will be generated during the pilot-scale demonstration. It should however be considered when the results of the demonstration are evaluated and during design of a full scale system.

3.0 Results of Vendor Evaluations

One of the major outputs of the technical effort completed during this project was the development of conceptual designs for transportable, pilot-scale test units. These designs were completed to facilitate estimation of costs of the demonstrations, to allow determination of facility support requirements, and in general to advance the USAEC's planning efforts for testing of red water treatment technologies. In order to complete the conceptual designs, the project team identified equipment vendors which could provide either the WAO or the CBC equipment. A summary of the effort to identify potential equipment and technology vendors is presented below.

3.1 Wet Air Oxidation

An initial list of candidate vendors believed to be capable of completing the required conceptual designs was developed by reviewing the following publications:

- A Compendium of Technologies Used in Treatment of Hazardous Wastes (EPA/625/8-87/014)
- Pollution Equipment News
- Chemical Engineering
- Thomas Register.

From this review, the following companies were found to be actively involved in the design of WAO systems:

- Air Products & Chemical, Allentown, Pennsylvania
- Kenox Corporation, Mississauga, Ontario
- Modar, Inc., Natick, Massachusetts
- Zimpro, Inc., Rothschild, Wisconsin.

Each of these companies was contacted and a Statement of Qualifications (SOQ) was solicited. A summary of each vendor's capabilities regarding bench-scale testing, pilot-scale testing, and full-scale units in operation is provided in Appendix D. In general, information gained from vendor contacts indicated that no transportable or RCRA permitted fixed base units currently exist that could operate at the USAEC-specified operating conditions (i.e., 280°C to 340°C (540°F to

640°F) and pressures up to 3000 psig). These design conditions were based on the earlier bench-scale testing conducted by USACERL.

Brief overviews of each vendor's technology is presented below:

- Air Products - this vendor's system uses a downhole reactor vessel extending 4,000 to 5,000 feet below the ground. The system was originally designed for the treatment of municipal sewage sludge, its application for treating industrial wastewaters is being explored by the vendor.

- Kenox Corporation - Designs and constructs WAO systems that operate at lower temperatures (235°C to 250°C) and pressures (700 to 800 psig) than the USAEC's initial requirements. The vendor contends that their proprietary design results in improved mass transfer which would allow the system to operate at lower temperatures and pressures and achieve the same treatment efficiencies as other systems operating at higher temperatures and pressures.

- Modar - This vendor specializes in supercritical water oxidation systems (SCWO). SCWO systems operate at temperatures and pressures above the critical point of water as opposed to WAO systems which operate below the critical point of water. SCWO systems are susceptible to plugging by inorganic solids and sodium salts.

- Zimpro - This vendor has over 20 years of experience in the design and operation of full-scale WAO systems using a concurrent vertical volume reactor. These systems typically operate at temperatures between 150°C and 315°C and pressures up to 300 psig. Previously, Zimpro performed bench-scale shaking autoclave tests on red water obtained from ICI Canada. During these tests, the process reduced the initial chemical oxygen demand (COD) level of 120 g/L by 90.3 and 99.5 percent at 280°C and 340°C, respectively.

Based on the review of the vendor SOQ's and responses received from a request for quotation (RFQ), Kenox was subcontracted by IT to prepare the conceptual design package for the WAO system. The selection was based on technical capability, schedule, cost, and contractual considerations. In the future, during the initiation of the demonstration, the vendor search and selection activity should be reviewed. In particular, any changes in availability (i.e., new vendors added or existing vendors who left the market) must be identified. The vendors should be provided detailed waste characterization data as well as samples of the red water that will be used for the demonstration.

3.2 Circulating Bed Combustion

CBC technology is utilized by a number of vendors in producing incineration systems to treat both hazardous and nonhazardous wastes. For example, fluid bed combustion systems are commonly used by municipalities and industry to treat wastewater treatment plant sludge wastes. IT technical personnel completed the conceptual design of the CBC demonstration unit (Appendix C). Since the original development of CBC technology by Ogden Environmental Services, the key process patents have expired, thereby lifting restrictions on the design of CBC units. As indicated in Section 3.1 for the WAO system, upon acquisition of red water by the Army and initiation of the demonstration, the equipment search and selection process should be include providing waste characterization data and samples to vendors and equipment design engineers for their use in the bidding process.

4.0 Conceptual Design

Descriptions of the WAO and CBC pilot-scale demonstration units are provided in this section. The complete conceptual designs and more detailed process information, as well as process flow diagrams, system controls, and the design basis are included in Appendices B and C. These conceptual designs are based on the limited database that currently exists on the characteristics of red water and are subject to change during completion of final designs. The conceptual designs present generic WAO and CBC systems and do not include proprietary aspects of these technologies. However, actual design may be facilitated by unique approaches that equipment vendors may provide. The pilot-scale WAO and CBC units have been designed to be transportable to enhance the flexibility of the USAEC's demonstration program. The units could be fabricated at the vendor's facility, loaded on trailers, transported to and assembled at the test site, and returned after use or used at another site on another waste if the need exists. Because of the nature of the technology, pilot-scale equipment is not currently available for rental, lease or purchase.

4.1 Wet Air Oxidation Demonstration Unit

The WAO demonstration unit consists of the following major components:

- Reactor section
- Reactor feed/effluent heat exchanger
- Reactor feed heater
- Effluent cooler
- Separators - high and low pressure
- Air compressor and accumulator
- Pumps - waste feed, dilution feed, high pressure feed, and effluent.

The USAEC's design basis for the WAO system stipulated that it must be capable of treating 1.5 gallons per minute (gpm) of red water at a chemical oxygen demand (COD) level of 120,000 mg/L. It has been assumed that dilution of the untreated red water will be used to reduce the COD to 60,000 mg/L because the high COD levels of the untreated red water would present safety concerns and may cause excessive evaporation in the WAO reactor. In the conceptual design, treated effluent from the WAO system is used to dilute the incoming feed. The design throughput of the diluted feed stream is therefore 3.0 gpm. Experimental data reported by Phull

(1992) predict that COD conversion in the range of 85 percent at a reaction temperature of 485°F (250°C) can be achieved.

It is anticipated that the corrosivity of red water will be aggravated under process conditions of high temperature, high pressures, and low pH of oxidized solutions (Phull 1992). The presence of sulfonated nitroaromatics is expected to contribute to this increase in corrosivity due to the formation of inorganic salts. On the basis of the previous corrosion testing (Phull), titanium was selected for use in the conceptual design as the material of construction for the WAO reactors and associated equipment and piping that contact process flows where the temperature will exceed 100°F. In areas where process temperatures will be less than 100°F, the selected material of construction for equipment and piping is 316 stainless steel.

Based on the evaluation of available data, review of the WAO process, and vendor input, the process conditions for the WAO system were assumed to include a reaction temperature of 485°F (250°C) and an operating pressure of 1000 psia; effective treatment at these conditions, which differ from those presented in Section 3.1, requires feed preparation, as described below. The following process description highlights the elements shown on the block flow diagram presented in Figure 4-1.

4.1.1 Feed Preparation and Preheat

Untreated red water will be contained in an on-site storage tank from which it will be pumped to a mix tank where the pH will be adjusted to 5 by the addition of sulfuric acid. The diluted feed will enter the tube-side of the reactor feed/effluent heat exchanger where its temperature will be raised to the required inlet temperature by transfer of heat present in the effluent from the reactors. During start-up, an electric heater will be used to heat the feed to the desired reaction temperature.

4.1.2 Reaction and Separation

The conceptual WAO system includes a set of reactors connected in series. Compressed air will be injected into the reactors to supply the oxygen required for the reaction. The combined oxidized liquid and spent air will be withdrawn from the reactors and cooled to 104°F in the reactor feed/effluent heat exchanger and effluent cooler. Gases and oxidized wastewater will leave the effluent cooler and enter a two-stage pressure let-down and separation system.

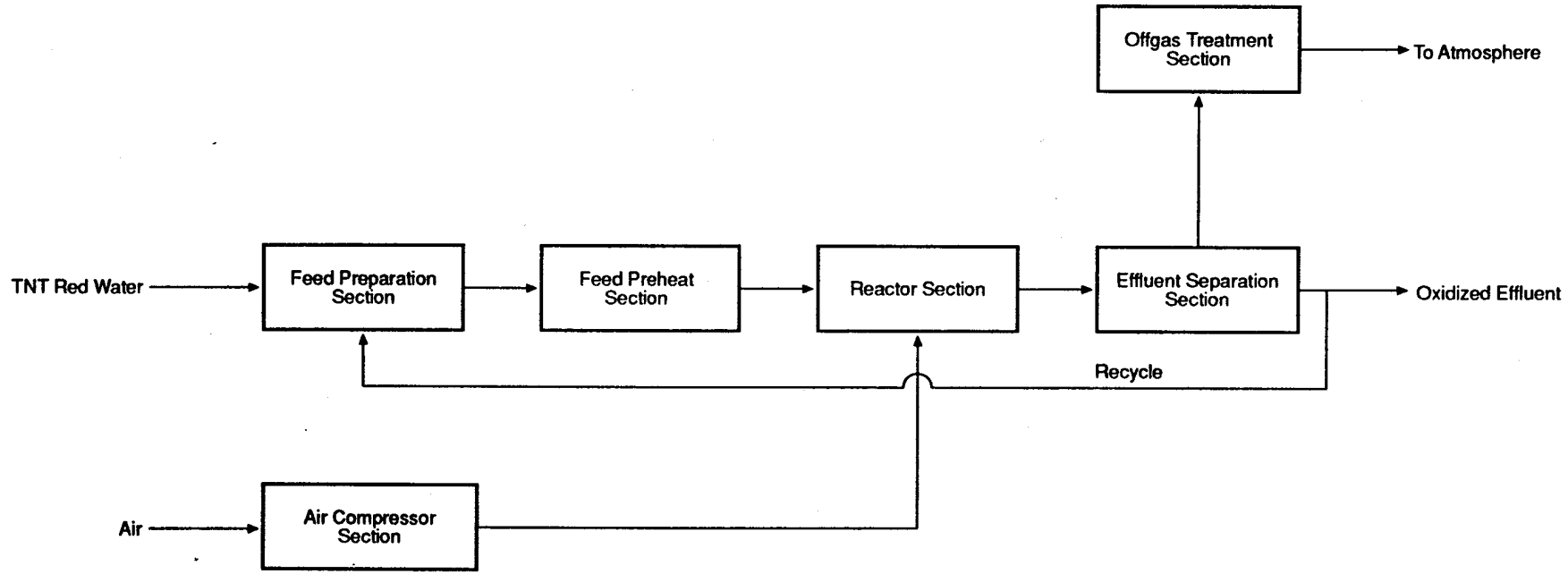

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Figure 4-1.
WAO Test Unit Block Flow Diagram.

DRAWING BY	JEM 2/1/95	CHECKED BY			DRAWING NO. M-322243-5-1-1-2/95-D
		APPROVED BY			

The off-gas, which is anticipated to be primarily carbon dioxide, nitrogen, and water vapor, will be monitored and vented to the atmosphere (though an emission control system if required by permit restrictions). Approximately half of the oxidized wastewater will be recycled to the inlet of the system, for dilution of feed. The remaining wastewater will be discharged for subsequent treatment to an on-site wastewater treatment plant if permitted or stored for subsequent disposal at a permitted TSDF.

4.1.3 Compressed Air

The compressed air (1050 psia) for the reactors will be produced by a reciprocating compressor and stored in an air accumulator prior to injection into the WAO reactors. The total air flow to the reactors will be controlled by an oxygen analyzer which measures the oxygen content of the off-gas leaving the system.

4.1.4 Facilities Support/Utility Requirements

The minimum utilities required for the operation of the WAO system are estimated to be:

- Electricity - 165 kilowatts
  - Voltage - 240/480
  - Max amps - 300 (full load)
  - Phases - 3
- Noncontact cooling water - 95 gpm
- Instrument air - 6.4 acfm at 100 psi.

It is estimated that the pilot-scale WAO unit will require an area sufficient for placement of two 40 ft by 8 ft trailers. Additionally sufficient space for placement of storage for untreated red water (influent) and treated effluent must be provided. The test area must be designed to meet the requirements of the RCRA permit. At a minimum, double containment must be provided to contain any leaks.

4.1.5 Scale-Up Factors for Full-Scale Units

The pilot-sale WAO unit is a scaled-down version of a full-scale unit and employs the same principles of heat and mass transfer. It is designed to operate at the same residence time, temperatures, and pressures that would be used in a full-scale unit of this design. The scale-up to a full-scale WAO unit from the pilot-scale data will involve revising the heat and material

balance calculations for the desired red water throughput. Full-scale design will require assessing the following information obtained during tests:

- Feed material evaporation rate
- Feed material dilution requirements
- Destruction efficiency
- Off-gas composition, volume, and required treatment
- Residuals (e.g., treated red water) handling and disposition.

The Test Plan (presented in a separate document) was designed to acquire the data necessary to support full-scale design.

4.1.6 WAO Treatability Test Program

A preliminary assessment of the potential effectiveness of the conceptual WAO design was completed by the equipment vendor (the results of which are in Appendix E) using red water obtained by the vendor from European sources. The objectives of the bench-scale treatability tests were to:

- Demonstrate the feasibility of WAO to treat red water under the operating temperature range in the conceptual design

- Determine the design parameters (e.g., WAO reaction temperature, pH of feed, and residence time) of the WAO pilot plant.

Conclusions from the treatability test program include:

- The COD removal was 88% at a reaction temperature of 250°C and pH adjustment to 4

- The nitrite in the red water oxidized to nitrate, as evidenced by the decreased nitrite level at the end of the WAO test runs

- The inorganic sulfite in the red water oxidized to sulfate, or the SO_3 groups associated with the DNTS and other sulfur-bearing organic compounds in the red water desulfonated.

These results indicate that the conceptual WAO system can be effective at treating red water.

4.2 Circulating Bed Combustion Demonstration Unit

The conceptual pilot-scale CBC unit is designed to be a transportable incineration system consisting of the following major components as shown on the block flow diagram in Figure 4-2:

- Red water feed system
- Combustion system
  - loop seal
  - circulating bed combustion zone
  - hot cyclone
- Ash handling system
- Air pollution control system
  - partial quench section
  - baghouse
  - induced draft (I.D.) fan
  - stack.

Untreated, undiluted red water will be fed to the CBC system where it will be thermally treated. Combustion by-products (ash) and spent bed material will be cooled indirectly by water in an ash cooler-conveyor. Incinerator off-gases will be ducted to a partial quench section where they will be cooled to about 400°F. The cooled combustion gases then will pass through a baghouse where more than 99 percent of the particulates will be removed. The cleaned combustion gases then will pass through an induced draft fan and be discharged to the atmosphere via the stack. Depending on permit requirements, an afterburner also may be required.

The operating temperature in the combustion chamber will be maintained at 1600°F by injecting auxiliary fuel (natural gas) directly to the chamber. The system is designed to process 1.5 gpm of red water (assumed heating value of 487 British thermal units per pound [Btu/lb] with a heat release of 0.4 MMBtu/h). The total thermal input to the system will be 4 MMBtu/h. It is calculated that the gas velocity through the combustion chamber will be 20 feet per second (ft/sec) and the gas resident time in the combustion chamber will be 2.2 seconds.

The major features of the CBC system are summarized in the following paragraphs; additional details are presented in Appendix C.

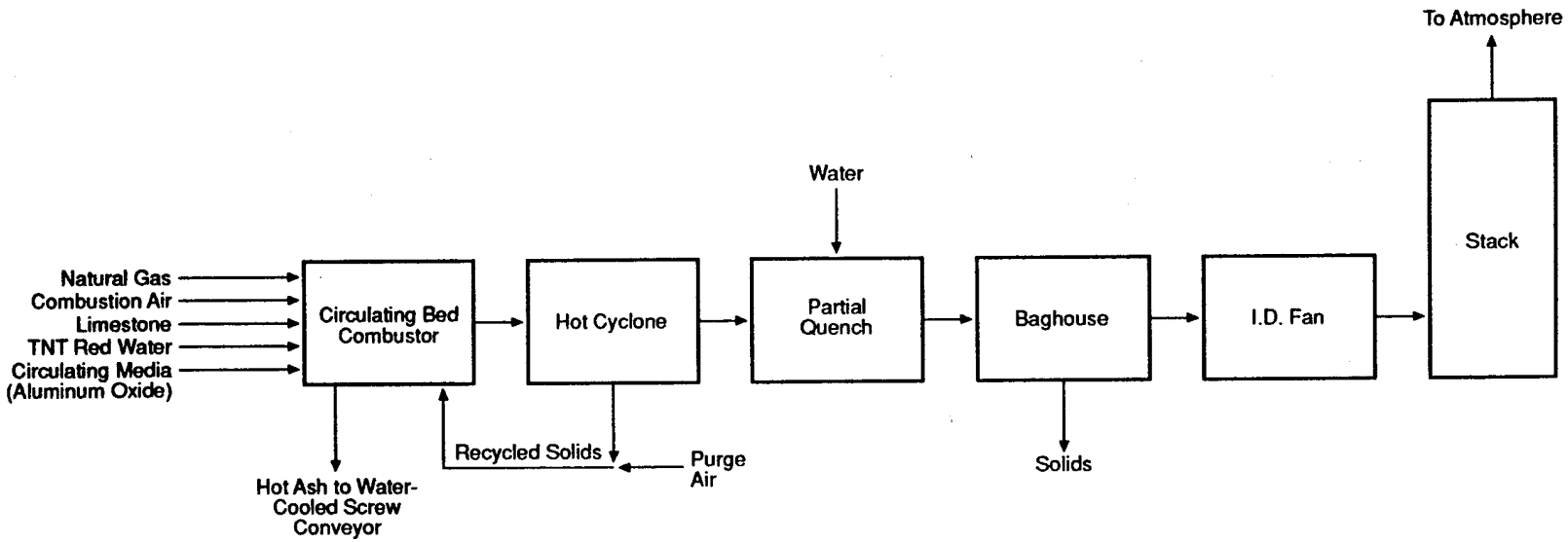

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Figure 4-2.
CBC Test Unit Block Flow Diagram.

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4.2.1 Feed System

The conceptual CBC demonstration unit has three major feed streams: untreated red water, circulating media (e.g., aluminum oxide), and limestone (to reduce sulfur dioxide [SO_2] emissions). The red water and the circulating media will be fed to the combustion chamber directly through the loop seal. Limestone will be fed into the circulating bed at a point above the main mass of the circulating media. The separate feed rates will depend on the composition of the red water and the composition of the combustion gas (e.g., oxygen and sulfur dioxide).

4.2.2 Combustion System

The combustion system consists of three elements: the loop seal, circulating bed combustion zone, and a hot cyclone (Figure 4-3). Red water enters the system at the loop seal. It will be mixed and blended in the combustion zone by the turbulence of the combustion air and the circulating media.

The circulating bed combustion zone has the following elements:

- Wind box distributor/assembly - a refractory-lined, carbon steel unit that receives combustion and circulating air; in addition a 5 MMBtu/hour start-up burner is mounted in the wind box.

- Combustion chamber - a refractory-lined, carbon steel vertical, cylindrical chamber located above the wind box distributor plate.

- Circulating bed - located above the wind box assembly, the bed is comprised of bed media and limestone and acts as a large thermal flywheel for efficient heat transfer to the red water.

At temperatures greater than 1300°F, up to 4 MMBtu/h of auxiliary fuel will be fed directly to the CBC. Primary air will be provided to the start-up burner by the combustion air blower. Fluidizing air (secondary air) will be fed directly to the wind box by the combustion air blower. The quantities of fuel and air fed to the CBC will be monitored and controlled to maintain the design flow rate and temperature. Off-gases from the CBC, which include carry-over spent bed media will pass through a hot cyclone for recovery of bed material. The gas will then be treated in an air pollution control system (APCS). Bed material recovered from the cyclone separator will be returned to the bottom of the circulating bed through a loop-seal.

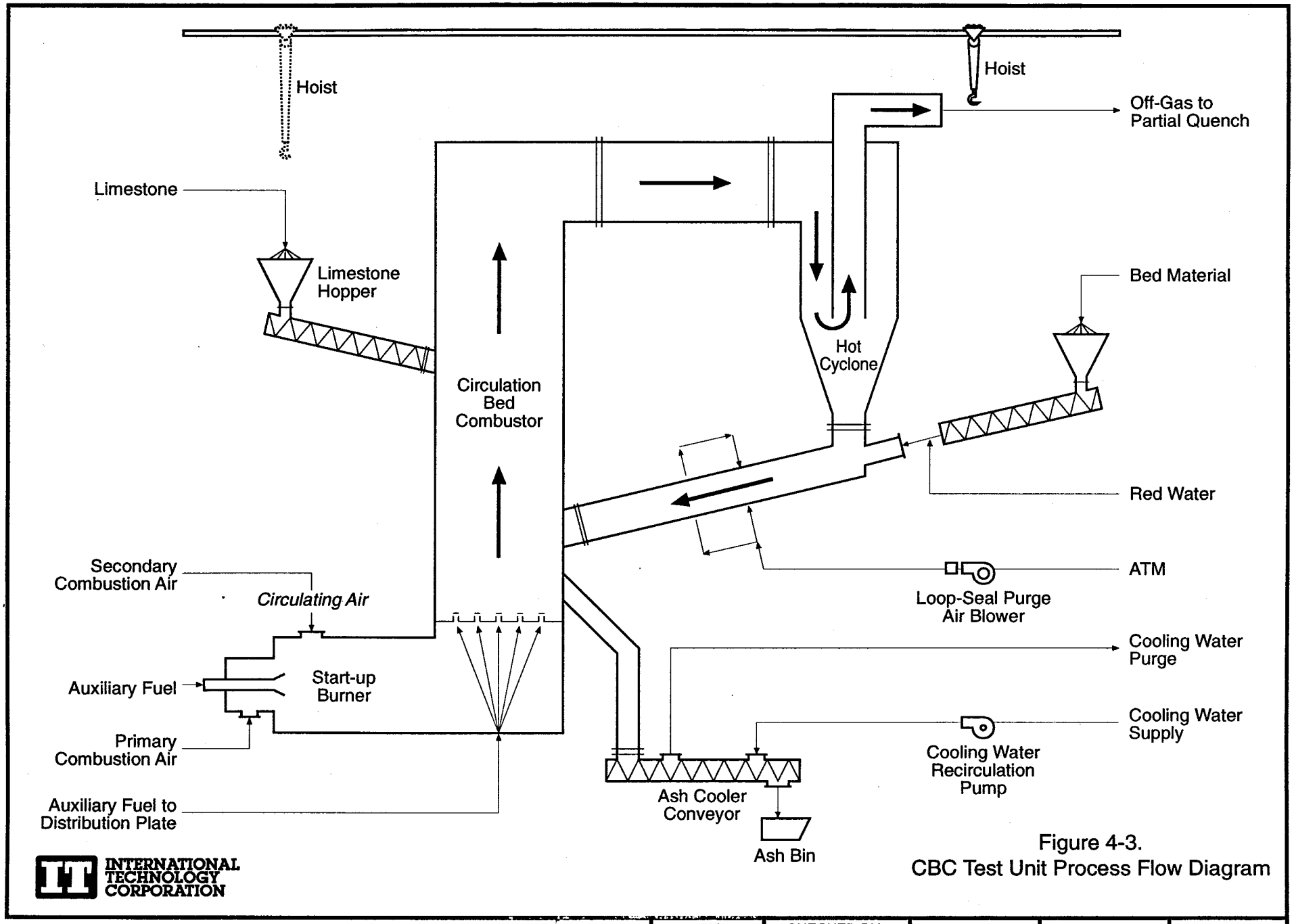

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Figure 4-3.
CBC Test Unit Process Flow Diagram

DRAWING BY	JEM 6/12/95	CHECKED BY			DRAWING NO. M-322243-6-1-6/95-D
		APPROVED BY			

4.2.3 Ash Handling System

Ash and spent bed media will be purged continuously from the combustion chamber and cooled by an ash cooler conveyor. These materials will be discharged to an ash bin.

4.2.4 Air Pollution Control System (APCS)

At a minimum, the APCS will consist of a partial quench section (to cool the off-gas), baghouse (for control of particulates), induced draft fan (I.D.), and a stack. Gases exiting the hot cyclone will pass through the partial quench, which will cool the gases by water spray to approximately 400°F in preparation for particulate removal in the baghouse. A baghouse will be used to remove more than 99 percent of the particulate matter entrained in the gas. After the baghouse, the gases will enter an I.D. fan and be discharged through a stack to the atmosphere. However, an afterburner may be required by the RCRA permit for the demonstration to ensure destruction of hazardous compounds.

4.2.5 Facilities Support/Utility Requirements

The minimum utilities required for the operation of the CBC unit include the following:

- Electricity
  - Voltage - 240/480
  - Max. amps - 225 Kva
  - Phases - 3
- Plant air - 928 scfm at 100 psi
- Instrument air
- Auxiliary fuel (natural gas) 4 MMBtu/h (182 lb/hr).

It is estimated that the pilot-scale CBC unit will require an area of approximately 120 ft by 50 ft and a storage area for four trailers. This does not include the feed storage and handling system. The entire area will have to be constructed to meet permit requirements. At a minimum, double containment will be required.

4.2.6 Scale-Up Factors for Full-Scale CBC Units

The pilot-scale CBC is a scaled-down version of a full-scale unit and employs the same principles of heat and mass transfer. It is designed to operate at the same residence time and temperatures that would be used in a full-scale unit. The scale-up to a full-scale system from the pilot-scale

demonstration data will involve revising the heat and material balance calculations for the desired red water throughput. The heat duty and size of the full-scale unit can be determined from the experience gained in preparing incineration systems for other waste streams.

Full-scale design will require assessing pilot-scale data for the following issues:

- Operating conditions necessary to achieve required DRE (destruction removal efficiency) of target compounds.
- Agglomeration in the circulating bed media.
- Entrainment of bed media in off-gases (carry-over).
- Off-gas composition, characteristics and volumes to define controls needed.
- Composition, characteristics and volumes of residuals (e.g., ash) to define handling and disposition.

The Test Plan, provided under separate cover, has been designed to address these issues and provide the data necessary for full-scale design.

4.2.7 CBC Treatability Test Program

An initial assessment of the potential effectiveness of the conceptual CBC design was conducted (the results of which are in Appendix F of this document and summarized in Section 18 of the Conceptual Design Report (Appendix C)) using a surrogate red water solution. The objectives of the bench-scale treatability tests were to:

- Evaluate agglomeration tendencies of two bed materials (aluminum oxide and zircon silicate)
- Assess combustion efficiency and the off-gas composition.

These tests indicate that the fluid bed agglomerated at a bed temperature of 745 to 804°C (1373 to 1840°F) irrespective of the bed material. In addition, the off-gases had high concentrations of nitrogen oxides, which were likely related to salts present in the surrogate red water. Despite the poor mixing in the fluidized bed (caused by the agglomeration of the bed material), combustion efficiencies were in the range of 98 to 99 percent, thereby indicating that CBC can potentially be an effective technology for the destruction of red water.

5.0 Implementation Plan for Demonstrations

The following steps must be completed during the next phase of project activities (i.e., implementation of the pilot-scale demonstrations):

- Review technologies applicable for the treatment of red water to confirm selection of WAO and CBC
- Identify a host facility or facilities
- Identify a source of red water
- Characterize the red water
- Update and complete the regulatory review based on specific test site requirements, waste source, and characteristics
- Obtain the necessary permits
- Prepare the final designs for WAO and CBC systems
- Revise Test and Health and Safety Plans
- Confirm site support requirements
- Fabricate, deliver, and install the WAO and CBC systems
- Complete shake-down testing and train equipment operators
- Conduct the pilot-scale demonstrations
- Treat/dispose project residuals
- Evaluate data and document results.

Each of these steps is discussed in the following sections.

5.1 Review Technologies

Previously, the USAEC completed comparative evaluations of 30 potential technologies for the treatment of red water (PEI, 1990). This study was conducted to identify treatment technologies

that are potentially acceptable for treating red water based on technical, economical, and environmental considerations. As a result of this study, WAO and CBC were determined to be applicable and sufficiently advanced for pilot-scale demonstration testing. Because a significant period of time will have lapsed between the technology evaluations and the implementation of demonstration, the technology evaluation and selection process should be updated. By the time of the demonstrations, new technologies may have been developed or existing technologies advanced to an extent that they could provide better treatment and/or lower cost. To provide a consistent basis of evaluation, the technical approach used for the technology review and evaluation should be similar in that used during completion of the earlier reports (PEI, 1990 and CSL, 1980). This review process is summarized in the following sections.

5.1.1 Technology Identification and Screening

The first step in the review process will be to determine if new technologies have developed or if technologies previously reviewed have benefitted from additional development. In determining if new technologies have emerged, the following procedures could be implemented.

- Identify current treatment technologies used at TNT production facilities or commercial treatment facilities that treat red water.
- Conduct a literature search to identify innovative or emerging technologies.
- Request proposals from treatment technology vendors/suppliers for treating red water (e.g., via a Commerce Business Daily (CBD) announcement or other mechanism with a wide-range distribution).

Following identification of potentially applicable technologies, an initial technical screening should be conducted. The screening should be conducted on the same basis as that presented in the USAEC's 1990 evaluation. CBC and WAO should be included in the screening process to ensure that all technologies are evaluated on an equal basis.

The findings of the screening effort should be summarized in a technical report and subjected to peer review by USAEC, USACERL, RAAP, ARDEC, and other technical personnel involved with the red water treatment project.

5.1.2 Technology Evaluation

Technologies passing the screening process should be subjected to detailed evaluation to determine if the technology(ies) warrant demonstration. A ranking system (e.g., a weighted scale) should be used to prioritize the technologies. It is anticipated that two technologies will undergo demonstrations. These will be CBC and WAO unless significant changes in other candidate technologies have occurred. For the purpose of the current project, it is assumed that CBC and WAO will be the technologies demonstrated. It is assumed that the demonstration of technologies other than CBC and WAO would require that similar steps be conducted for demonstration of other technologies.

5.2 Identify a Host Facility or Facilities

The first step necessary to implement the technology demonstration project will be to identify a host facility or facilities. The host facility may be:

1) An AAP that produces TNT
2) Another facility that produces TNT
3) An AAP which can receive and handle red water
4) Another facility which can receive and handle red water.

Currently, the Army does not produce TNT and, therefore, does not generate red water. It is not anticipated that an AAP will be brought on-line to produce TNT in the near future. Due to these facts, Option No. 1 above is not considered to be a viable option for the demonstration. The Army currently purchases TNT from ICI Explosives Canada located in McMasterville, Quebec. Two potential options exist regarding this potential source of red water: acquire red water for testing at another facility or conduct the tests at the point of generation. At this time, the potential of acquiring red water appears less feasible than conducting tests at this location. However, extensive negotiations would be required in either case. Importing red water may not be a viable option, due to technical and legal restrictions, because each demonstration test may require over 25,000 gallons. Identification of a host facility will also require review of all applicable regulations and existing facility permits. This will require reviews and discussions with the facility owners and operators and local, state, and federal regulations.

5.3 Identify a Source of Red Water

This step of the planning process may be accomplished during identification of a host facility if it is decided to conduct the demonstrations at the point of generation. The existing database

suggests that the characteristics and composition of red water can vary significantly. This is due to the fact that MIL SPEC grade TNT can be produced over a range of process and operating parameters and with various feed stocks. Red water acquired for the demonstration tests should ideally be obtained from a process similar to that which would be used by the Army for the production of TNT (i.e., the continuous CIL process).

5.4 Characterize the Red Water

Upon identification and acquisition of a source of red water, the red water must be thoroughly characterized. The existing database regarding the chemical, physical, and toxicological characteristics of red water is extremely limited. This is primarily due to the fact that red water has not been generated at Army facilities for a number of years. During the time of generation, the need for detailed characterization did not exist; therefore, an extensive analytical database was not compiled. In addition, analytical methodology associated with the quantitation of the unique compounds present in this complex waste was not well advanced.

Characterization should include the analyses presented in the Test Plan developed for this project. These analyses may require development or modification of analytical techniques for quantitation of unique compounds in a unique matrix. Additionally, the variability of the waste should be assessed and reviews of chemical and physical hazards must be completed. Adequate characterization data is required to meet regulatory requirements for transport, storage, and handling of red water. The data must also be made available to the equipment design team to ensure compatibility of materials and for development of appropriate operating and test conditions.

5.5 Update the Regulatory Review

An initial regulatory review was conducted as part of this project to determine which regulations and requirements would be potentially applicable to the WAO and CBC demonstrations. This regulatory review also included a determination of potentially applicable regulations and requirements for full-scale implementation to determine potential testing requirements. Because the regulations may be changed, or new regulations may be enacted before the demonstrations are conducted, the regulatory review must be updated to ensure that the tests are conducted in compliance with all applicable regulations. Additionally, once the host facility is identified, a regulatory review of the specific local and state requirements must be conducted.

5.6 Obtain the Necessary Permits

It is anticipated that regulatory requirements will require modification of existing permits or acquisition of new permits under RCRA, CWA, CAA or other local, state, and/or federal regulations. The host facility will be required to prepare and submit the necessary documents and to interact with the regulators. The USAEC contractor may be directed by their scope of work to provide technical and regulatory support in this regard. Such support may include participation in disclosure meetings with regulatory agencies, providing technical support and engineering documents and/or calculations, and preparing drafts of the necessary submittals. Any support effort should be closely coordinated with the environmental staff of the host facility and the USAEC. All documents should be prepared for the signature of the Commander of the host facility (if an Army facility is used). Any communications between contractors and regulators should be conducted at the direction of and as authorized by the USAEC and the facility Commander.

As indicated in the Regulatory Review Report (Appendix A), the following regulatory actions are necessary to perform the pilot-scale demonstration tests:

- Obtain/modify RCRA, CAA, and CWA permits
- Prepare red water and documents for proper shipping; this includes manifests, packaging, labels, and placards.
- Obtain permits and dispose of residues as required:
  - For discharge of treated waste to surface water, obtain a NPDES and state discharge permit, including a permit to install and a permit to operate a wastewater treatment system.
  - For discharge to a POTW, obtain a discharge permit from the regulatory agency governing discharge to the POTW.
  - For landfill of ash as a nonhazardous waste, petition U.S. EPA for exclusion of the treated ash from 40 CFR 261; obtain disposal approval from the landfill.

- For shipment of the WAO-treated effluent or the CBC ash to a RCRA TSDF, determine the DOT hazardous material proper shipping name and shipping requirements; obtain disposal approval from the TSDF; prepare hazardous waste manifests.

- Verify the compliance status of the facilities used for disposal.

Further information on the regulations and procedures listed above is presented in the Regulatory Review Report in Appendix A.

5.7 Prepare Final Designs for WAO and CBC Systems

The designs presented in Appendix B and Appendix C of this Project Report represent conceptual designs for WAO and CBC pilot-scale systems, respectively. The designs for these systems will require finalization prior to implementation of the pilot-scale demonstration test program. The designs can be finalized by preparation of a request for proposal (RFP) for each of the two technologies selected for pilot-scale implementation. The scope of work to be outlined in these RFPs should include the following tasks:

- Prepare process (i.e., 30 percent) and final (i.e., 100 percent) designs
- Review Test Plan
- Review Health and Safety Plan
- Fabricate pilot-scale equipment
- Prepare and provide equipment operating plan
- Transport and install pilot-scale equipment
- Shakedown and prove systems.

Upon receipt and evaluation of the vendor proposals, a vendor can be selected to complete the final design and implementation of the respective technologies. If the results of the evaluation indicate that another technology will replace WAO or CBC (or possibly two other technologies will replace both CBC and WAO), the RFP should include the preparation of a preliminary design as the first item in the scope of work, followed by the process and final designs.

5.8 Revise Test and Health and Safety Plans

The Test and Health and Safety Plans will require review and modification prior to implementation to reflect:

- Actual red water characterization data
- Changes in equipment design

- Changes in regulations and other health and safety requirements
- Protocols and requirements of the host facility.

It is anticipated that, regardless of the host facility selected, that site-specific health and safety protocols will exist that will have to be incorporated into these project plans. If the demonstration takes place at an AAP, a series of reviews by plant safety and hazards analysis personnel will be required. Formal submittals including a site-specific Safety Submission and detailed Unit Operating Procedures (UOPs) will likely be required. Reviews will include determination of chemical, physical, and explosive hazards including definition of quantity-distance relationships for all potentially explosive materials. These reviews and approvals can be time consuming and complex in nature. Therefore, site personnel should be involved as early as possible in the process.

5.9 Confirm Site Support Requirements

Preliminary site support requirements necessary for conducting the WAO and CBC demonstrations are described in Sections 4.1.4 and 4.2.5. These requirements are based on the conceptual designs for the two test systems. During completion of the final designs, the specific site support requirements must be reviewed to ensure all site support requirements necessary for implementation of the pilot tests have been identified. The host facility should be involved in this process so that any limitations or restrictions are identified and dealt with early in the design phase.

In general, the site support requirements will include the capability to safely receive, handle, and store approximately 50,000 gallons of red water. The host facility will also provide the utilities (electric, water, compressed air, etc.), as specified in the previous section, and the support personnel and equipment necessary to off-load and assemble and later to disassemble and remove the test units (e.g., electricians, riggers, plumbers, and other craftsmen). These craftsmen will be responsible for making the necessary terminal connections of plant utilities to the test equipment. It is also anticipated that the host facility will provide the equipment operators, health and safety oversight, regulatory support, maintenance, and other staff resources.

Ideally, the site support will include on-site analytical services. This will avoid off-site shipment of samples. Additionally, a dedicated on-site laboratory capable of conducting the unique analyses

required will minimize analytical turnaround times and allow the project engineers to make timely decisions during performance of the tests.

5.10 Fabricate, Deliver, and Install the WAO and CBC Systems

Once the final equipment designs have been approved, the fabrication of the system can be initiated. During this period, the USAEC, USAEC contractor, and representatives of the host facility should visit the equipment vendor during strategic times (e.g., initiation, 50 percent completion, and at completion). The purpose of these visits is to ensure compliance with design specifications, and to review in detail design/construction details that may affect system safety and reliability. The acquisition package should include testing of the system at the vendor's location to prove the system prior to shipment to the test site.

After completion of the fabrication and pre-shipment testing, all parties involved (e.g., USAEC, USAEC contractor, vendor, host facility) must coordinate shipment and delivery of the system. This coordination is essential, especially if an AAP is the test site, to ensure that the system can be received and off-loaded without problem, that the necessary riggers and craftsman are available, and that the facilities receiving department is notified and aware of the delivery. Prior to shipment, preparations at the test facility should be completed (e.g., placement of utilities, building and pad construction, etc.).

5.11 Complete Shake-Down Testing and Train Equipment Operators

Once the systems have been installed, all utility connections have been made, and any necessary safety reviews completed, shake-down testing can be initiated. Typically, initial shake-down would be conducted using plant water. This allows the system to be checked for leaks and other problems without the added complexity of handling hazardous materials. It also allows the equipment operators to be trained on the system under favorable conditions.

5.12 Conduct the Pilot-Scale Demonstrations

After all reviews and testing and training have been completed, the test plan can be implemented. The demonstration tests will likely require a minimum of 1 to 3 months for each technology. During this period, the USAEC contractor will likely be tasked with providing on-site oversight to ensure compliance with the Test Plan and the Health and Safety Plan. This will also facilitate the contractors understanding of the system and allow real-time review of performance data.

5.13 Treat/Dispose Project Residuals

During the performance of the test program, all project residuals must be collected and contained in accordance with regulatory permit requirements and in a manner consistent with the Health and Safety Plan. This will include determination of the volume of residuals produced, sampling and analysis to characterize the residuals and subsequent determination of appropriate treatment/ disposal options.

5.14 Evaluate Data and Document Results

The operational and analytical data collected during the performance of the demonstration will be compiled and analyzed to determine treatment efficiency (e.g., destruction removal efficiency), determination of optimal operating conditions, and estimate the costs of treatment. The results will include discussion of the characteristics of the untreated red water and the characteristics of all residuals, effluents, and emissions. The assessment should be conducted to confirm that all environmental regulations/restrictions and safety requirements can be met by the technology evaluated. It will also include an assessment of optimization of operating parameters including utility usage. Identification of health and safety concerns at both the pilot- and full-scale should also be addressed. Draft and final reports detailing the demonstration will be prepared in accordance with DD Form 1423, Sequence A003. The reports should provide a concise comparison of the performance data for each system to support selection of one of the technologies for implementation at full scale.

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APPENDIX A

REGULATORY OVERVIEW FOR PILOT-SCALE DEMONSTRATION AND FULL-SCALE TREATMENT OF RED WATER (K047)

FINAL

REGULATORY OVERVIEW FOR PILOT-SCALE DEMONSTRATION OF RED WATER TREATMENT TECHNOLOGIES

Prepared for:

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List of Acronyms

AQCR	Air Quality Control Region
BACT	best available control technology
C	ceiling value
CAA	Clean Air Act
CBC	circulating bed combustion
CFR	Code of Federal Regulations
COD	chemical oxygen demand
CWA	Clean Water Act
DOT	U.S. Department of Transportation
DRE	destruction and removal efficiency
dscf	dry standard cubic feet
EPA	U.S. Environmental Protection Agency
HAP	hazardous air pollutant
HCl	hydrogen chloride
kg	kilogram
MACT	maximum achievable control technology
mg/L	milligrams per liter
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standard for Hazardous Air Pollutant
ng/m^3	nanograms per cubic meter
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
OSHA	Occupational Safety and Health Administration
PIC	products of incomplete combustion
POHC	principal organic hazardous constituent
POTW	publicly owned treatment works
ppm	parts per million
PSD	Prevention of Significant Deterioration
RAAP	Radford Army Ammunition Plant
RCRA	Resource Conservation and Recovery Act

List of Acronyms

RD&D	Research, Demonstration, and Development (permit)
SAC	significant ambient air concentration
STEL	short-term exposure limit
TLV	threshold limit value
TNT	trinitrotoluene
tpd	tons per day
tpy	tons per year
TSDF	treatment, storage, and disposal facility
TWA	time-weighted average
USAEC	U.S. Army Environmental Center
VR	Virginia regulation
WAO	wet air oxidation

1.0 Introduction

This Regulatory Overview for Pilot-Scale and Full-Scale Treatment of Red Water (K047) was prepared by IT Corporation (IT) for the U.S. Army Environmental Center (USAEC) under Contract No. DACA 31-91-D0074, Delivery Order No. 5: "Red Water Treatment Technology Test Plan and Site Preparation." The USAEC is preparing to conduct pilot-scale demonstrations to determine the effectiveness of two technologies for treating red water. Red water is the aqueous effluent generated during purification of crude trinitrotoluene (TNT). The U.S. Environmental Protection Agency (EPA) has listed red water from TNT production as a hazardous waste based on its reactivity and has assigned it the EPA Hazardous Waste Number K047. Treatment, storage, and disposal of hazardous waste is regulated by EPA.

The objectives of the referenced Task Order were to prepare test and safety plans, to complete conceptual designs, and prepare equipment layouts for pilot-scale circulating bed combustion (CBC) and wet air oxidation (WAO) treatment systems. Because of uncertainty about the location of the pilot-scale demonstration, the pilot-scale units have been designed to be transportable. The conceptual designs have been developed to approximately the 10 percent stage under the referenced task order; further process engineering and detailed design engineering is necessary prior to construction of the pilot-scale units.

The objective of this review was to assess the regulatory requirements for the implementation of the pilot-scale test program, focusing on the management of untreated red water and the residues and emissions generated by the treatment processes. Although the requirements for the pilot-scale and full-scale red water treatment systems will likely be similar in many regards, they will not be identical due to differences in location, timing, etc.

This regulatory overview summarizes the requirements and regulations that should be considered prior to pilot-scale testing of WAO and CBC systems. This overview is not intended to be a comprehensive review of the regulations because of the uncertainties concerning the date and location of the demonstration and the source and characteristics of red water. Specifically, the objectives of this regulatory overview are to:

- Identify air, water, and hazardous waste regulations and requirements potentially applicable to the pilot-scale demonstration of WAO and CBC for treatment of red water.

- Review the regulations to determine the discharge and emission criteria to be used to judge whether the treatment systems can meet the applicable standards.

Other documents prepared for this task include a Test Plan, Health and Safety Plan, and a summary project report.

1.1 Regulations Considered

Because neither the date nor location have been determined for pilot-scale demonstration of the WAO and CBC systems, this regulatory overview considers only current federal and state requirements. Because environmental regulations may change, it is not possible to determine future requirements. Therefore, at the initiation of the final design and test phase, this overview must be reviewed and updated to reflect current requirements. For the purposes of this overview, it has been assumed that the red water treatment demonstrations will be performed and full-scale systems will subsequently be implemented in the Commonwealth of Virginia (except where noted in this report, the Virginia regulatory requirements are identical to the federal regulations). This assumption was made by the project team for the purpose of facilitating the regulatory review. It is not based on Army policy or mobilization plans regarding AAP's. When the actual location(s) for the pilot-scale demonstrations have been identified, the permitting requirements for the specific state(s) must be reviewed for specific limitations and requirements.

The potentially applicable requirements for the management of red water and red water residue are addressed under the following Federal acts:

- Resource Conservation and Recovery Act (RCRA)

- Clean Water Act (CWA)

- Clean Air Act (CAA)

- Hazardous Materials Transportation Act

- Occupational Safety and Health Act, administered by the Occupational Safety and Health Administration (OSHA).

1.2 Document Organization

- Chapter 2.0 summarizes regulations applicable to pilot-scale treatment facilities.
- Chapter 3.0 identifies residues and emissions that are likely to be generated during the WAO and CBC treatment processes, and reviews disposal options and regulatory requirements applicable to those residues.
- Chapter 4.0 presents a summary of the potentially applicable requirements and regulations for the management of red water and red water residue.

Specific regulatory citations are noted and discussed in each chapter. The management of red water residues generated during the demonstrations are subject to the same residue management requirements as a full-scale treatment systems.

2.0 Regulations and Requirements Applicable to Pilot-Scale Demonstrations

The red water treatment demonstrations may be conducted at the Radford Army Ammunition Plant (RAAP) in Radford, Virginia or at a vendor facility in Virginia or another state. During selection of the test site(s) the status of existing environmental permits should be reviewed and state and federal regulatory agencies should be contacted to determine the specific permitting requirements applicable to the demonstration. In particular, the state regulatory requirements must be reviewed to identify any specific limitations that are more stringent than the federal regulations.

2.1 General Requirements for the Test Facility

In order to ensure that the USAEC's waste treatment technology demonstrations are conducted in accordance with the intent and requirements of all applicable laws and regulations, a thorough review of all facility permit requirements must be conducted. The test facility must have appropriate permits issued under RCRA prior to installation of the demonstration system(s). The states may also require permits issued under the CWA and CAA. The review of the permit applications and public participation in the permitting process typically requires several months or years to complete. Therefore it is essential that early discussions be held with the regulatory agencies to prevent avoidable delays in the permitting process from impacting the project schedule.

The generation, storage, treatment, and disposal of EPA listed hazardous waste (i.e., red water) is regulated under the RCRA. RCRA regulations will apply to all phases of the demonstration from acquisition of the red water for testing through disposal of any and all project residuals. Significant administrative requirements, including permits, transportation manifests, training, etc. will be associated with a demonstration involving the quantities of red water envisioned for these demonstrations (~50,000 gallons).

The test (host) facility must have the appropriate RCRA permits and approvals prior to receipt of the red water. Two scenarios may be encountered in regard to the RCRA permitting of these demonstrations:

- Conduct the tests at a facility that has an existing RCRA Part B or RCRA RD&D permit.

- Conduct the tests at a facility that must obtain a RCRA Part B or RCRA RD&D permit.

Consultation with the agencies will be needed to determine the type of hazardous waste permit that will be required for the pilot-scale treatment systems. The RCRA permit may be a Research, Demonstration, and Development (RD&D) permit, a new RCRA permit, or a modification to an existing RCRA permit. An RD&D permit issued under Title 40 of the Code of Federal Regulations, Part 270, Section 65 (40 CFR 270.65) may give the facility more flexibility to test the effects of several parameters on the operation of the system than a general RCRA permit. An RD&D permit will most likely require the least amount of time to obtain. A RCRA RD&D permit application typically resembles a RCRA Part B application but on a smaller scale. The RD&D application would be expected to contain the following information:

- General description of the facility

- Waste analysis plan
  - waste characterization
  - waste acceptance procedures

- Process description
  - Red Water Storage System(s) Description
    Dimensions and capacity of tanks and containers
    Feed system(s), safety cutoffs, bypass systems
    Diagram of piping, instrumentation, and process flow
    Assessment of tank system integrity and compatibility
    Secondary containment
    Leak detection system

  - CBC System
    Engineering description of CBC
    Sampling, analysis and monitoring procedures
    Quality assurance/quality control procedures
    Trial burn schedule
    Test protocols to meet 99.99% DRE or other project goals
    Emission control equipment requirements and operation
    Shutdown procedures

- WAO System
  - Engineering description of WAO
  - Containment system
  - Operating standards
  - Evaluation of risk to human health and environment
    - prevention of releases to air, ground surfaces, surface water, and groundwater
  - Test protocols and performance standards

- Procedures to prevent hazards
  - Security system (electronic, physical, guards, etc.)
  - Inspection schedule for facility and equipment

- Contingency Plan (a stand alone document)
  - General description
  - Emergency coordinators (primary plus 3 alternates)
  - Implementation criteria
  - Emergency response procedures
    - notification
    - identification of hazards
    - hazard assessment
    - control procedures
  - Emergency equipment
  - Coordination agreements
  - Evacuation plan

- Personnel Training
  - Demonstrate personnel trained to operate system and react to irregularities. and emergencies

- Closure Plan
  - Closure performance standard
  - Maximum inventory
  - Schedule for closure
  - Inventory disposal, removal or decontamination
  - Cost estimate
  - Financial assurance

To obtain a new RCRA permit, the facility would have to submit a RCRA Part A and Part B Permit Application describing in detail the pilot-scale system and containing the information listed in 40 CFR 270.13, 270.14, and 270.19 or 270.23, a process that could take two years. If the test facility has an existing RCRA permit, a request to modify the permit (under 40 CFR

270.42) to add the pilot-scale demonstration system would require that the same information needed for a new permit would have to be submitted. Revision of an existing permit would likely take one to two years. A RCRA permit will require the CBC system to meet the standards in 40 CFR 264 Subpart O for incinerators, and the WAO system will be required to comply with the standards in 40 CFR 264 Subpart X for miscellaneous units. As a hazardous waste treatment, storage, or disposal facility (TSDF), each test facility must have a health and safety program that complies with the requirements of 29 CFR 1910.120 (OSHA-hazardous waste operations).

In terms of project schedules, obtaining a RCRA Part B permit would likely take a minimum of two years. Obtaining a RCRA RD&D permit would be anticipated to take at least 9 to 12 months. Modification of an existing permit would likely take about the same length of time. Because of the relatively short term test program and the limited number of technologies, obtaining a RCRA RD&D permit will probably be the most likely option. A RCRA RD&D permit application typically resembles a RCRA Part B application but on a smaller scale. Information on the facility, waste characterization, process descriptions, procedures to prevent hazards, contingency plans, personnel training, and a closure plan would be required.

A third scenario, conducting the demonstrations under the RCRA treatability exclusion, is not currently an option. The treatability exclusion rule (40 CFR 261.4(e) and (f)) allows for the shipment and testing of up to 10,000 kg of hazardous waste (~2,500 gallons of red water) without having to comply with RCRA manifesting or facility permitting requirements. Under this exclusion, however, the host facility would have to have an EPA Hazardous Waste Generator ID Number, and any residual would have to be disposed of as hazardous waste. Further, testing of nonbiological technologies must be completed within one year under the exclusion.

Contacts with the air and water permitting agencies should also be made at an early date to obtain forms and directions for applying for the needed permits (e.g., Part A and Part B permit). Usually the time required for review and public participation when issuing air and water permits is not as long as for a RCRA permit; however, several months may be required.

As with all other aspects of the demonstration, once the source and characteristics of red water are known and candidate host facilities have been identified, the project team can approach the

appropriate RCRA regulators (the U.S. EPA or the State in cases where the state has been granted RCRA primacy) to discuss specifics and define actual requirements.

2.2 Regulations Pertaining to Shipping and Manifesting Pilot-Scale Test Materials

The treatability sample exclusion rule at 40 CFR 261.4 (e) and (f) allows for the shipment of up to 2500 gallons (10,000 kilograms [kg]) of hazardous waste (i.e., red water) as a sample without having to comply with the RCRA manifesting requirements, providing certain conditions are met. However, the WAO and CBC demonstrations will require significantly more than this limit. Therefore, the shipments of red water to the test facility will be subject to the following regulations:

- Hazardous waste manifesting requirements of 40 CFR 262
- Hazardous materials identification, packing, labeling, and placarding requirements of 49 CFR 171 through 199.

Although red water is not specifically listed in the U.S. Department of Transportation (DOT) hazardous materials table (49 CFR 172.101), it is listed as a hazardous substance in the appendix to 49 CFR 172.101 because it is a hazardous waste. Therefore, prior to any shipment an appropriate generic, or n.o.s. (not otherwise specified), shipping name must be selected identifying the hazard class (and packing group, if any) of the material; for example, "RQ Waste Poisonous Liquids, Oxidizing, N.O.S. (K047)."

3.0 Regulation of Residues, Effluents, and Emissions

WAO is a high-temperature and high-pressure aqueous destruction process that generates wastewater, sludge, and air emissions. CBC is a thermal incineration process that generates ash and air emissions. The following section summarizes the regulations that pertain to these residues and emissions.

3.1 RCRA Applicability

Red water is listed in 40 CFR §261.32 as a hazardous waste from a specific source (pink/red water from TNT operations) based on its reactivity and has been assigned the EPA hazardous waste number K047. Red water may also exhibit one or more of the RCRA hazardous characteristics identified in 40 CFR 261, Subpart C including ignitability (D001), corrosivity (D002), reactivity (D003), and toxicity characteristics (D004-D043).

The RCRA "derived from" rule at 40 CFR §261.3© states that a "solid waste generated from the treatment, storage or disposal of a hazardous waste ... is a hazardous waste." Therefore, unless the residue from the treatment of red water at a specific site is delisted, it remains a hazardous waste and is subject to the storage and disposal requirements of RCRA. Delisting involves submitting a delisting petition in accordance with the requirements in 40 CFR §260.22. Due to the short duration of the demonstration and the limited residuals that will be generated, it is anticipated that delisting will not be a viable option.

The RCRA land disposal restriction treatment standards for K047 waste are specified as deactivation in 40 CFR §268.40. Deactivation is defined in Table 1 of 40 CFR §268.42(a)(3) as treatment to remove the hazardous characteristics of a waste due to ignitability corrosivity, and/or reactivity. The listing of K047 waste in 40 CFR §261.32 references reactivity as the basis for listing this waste. Appendix VI to Part 268 of 40 CFR includes a list of recommended technologies to achieve deactivation. The recommended technologies for non-wastewater include chemical oxidation, chemical reduction and incineration. The recommended technologies for wastewater include chemical oxidation, chemical reduction, biodegradation, carbon adsorption, and incineration. These technologies are not mandatory and other methods of treatment may be used if they achieve deactivation. The deactivated K047 residue would

retain the K047 hazardous as specified in 40 CFR §261.3(b) and 40 CFR §261.3(c). Deactivated residue may be landfilled at a Subtitle C (hazardous) landfill if the residue meets the landfill specific disposal requirements (or can be treated to meet those requirements) and if the landfill is permitted to manage K047 waste.

3.2 Disposal Options and Regulatory Requirements for Wet Air Oxidation Residues

WAO treatment of red water will result in generation of a liquid hazardous waste that can be disposed of in one of three ways:

- Treatment/disposal at a RCRA-permitted TSDF
- Discharge to a POTW
- Discharge to a body of water via a NPDES-permitted outfall.

Each of the three options requires compliance with different treatment standards, analysis of different parameters, and submittal of differing regulatory compliance documentation. Shipment of treated water to a RCRA-permitted TSDF would require the least treatment by the generator, whereas direct discharge to a body of water would require the greatest degree of treatment. The regulatory considerations for each of the three options identified above are outlined in the following sections.

3.2.1 Disposal of WAO Effluent at a TSDF

To gain acceptance for disposal of liquid effluents at a TSDF that is permitted to accept K047, the waste must be fully characterized and a sample of the waste submitted to the TSDF along with a completed waste profile form. An incoming waste must be properly characterized according to RCRA (40 CFR 261), DOT (49 CFR), and the requirements of the TSDF. The list of required analytical parameters may be modified on the basis of the generator's knowledge of the generation method. It is anticipated that the physical and chemical characterization of the effluent would include testing to determine its specific gravity, pH, reactivity, explosivity, RCRA toxicity characteristic leaching procedure (TCLP) results and the concentrations of numerous specific constituents such as cyanide, sulfide, phenolics, polychlorinated biphenyls, oil and grease, total organic carbon, total organic halogen, and RCRA metals. (If the waste conforms with the capabilities and permit restrictions of the TSDF it can be approved.) The generator must also comply with the requirements of 40 CFR 262. These requirements include waste accumulation time, manifesting, record keeping, and reporting. The hazardous waste

shipping requirements of 49 CFR for shipment of treated red water as outlined in Chapter 2.0 also must be met. Once approved, the waste can be properly containerized, placarded and transported under manifest by a RCRA permitted transporter. After the waste has been received and treated or disposed by the TSDF, a certificate of disposal is issued to the generator confirming the final disposition of the material.

Preliminary contacts with commercial, RCRA permitted TSDFs regarding their ability to accept K047 indicate that several facilities are currently permitted to accept K047 with some limitations. A list of these TSDFs and their K047 waste acceptance criteria is presented below. This list is meant to serve only as an indication that permitted TSDF's currently exist that could potentially accept residues from the pilot-scale demonstrations. This list does not indicate any commitment by these TSDFs to receive K047. Waste approvals are granted on a case-by-case basis and depend on the specific characteristics of the waste.

TSDF	Treatment Type	Location	K047 Waste Acceptance Criteria
Chemical Waste Management	Incineration	Port Allen, TX	Acceptable unless DOT hazard class 1.1 or 1.2
Trade Waste Incineration	Incineration	Sauget, IL	Acceptable unless DOT hazard class 1.1 or 1.2
Essex Waste Management	Deactivation	Kingsville, MO	No limits/bulk or drum
ICI Explosives	Incineration	Joplin, MO	Cannot accept liquids; liquids must be absorbed on sawdust or polymeric resin
Chemical Waste Management	Landfill	Model City, NY	K047 must be deactivated and meets land disposal restrictions

3.2.2 Disposal of WAO Effluent at a POTW

Discharge of the WAO residuals (i.e., treated red water) to a POTW subjects it to regulation under Section 402 of the CWA, as amended, and, if in Virginia, to the corresponding Com-

monwealth of Virginia regulations (VR 680-14-01). Part VII of VR 680-14-01 establishes the legal requirements for state, local government, and industry to implement National Pretreatment Standards for the control of pollutants which pass through or interfere with treatment processes in POTWs or which may contaminate sewage sludge. Section 7.2 of VR 680-14-01 incorporates some federal regulations regarding pretreatment standards. The Virginia regulations incorporate sections of the federal regulations regarding categorical standards, removal credits, POTW pretreatment programs, guidelines for test procedures, variances from pretreatment standards, calculations, by-pass, modification to the POTW's program, and most of the National Categorical Pretreatment Standards. The federal categorical pretreatment standards for explosives manufacturing (40 CFR 457) are not incorporated into VR 680-14-01 by reference. The Virginia State Water Control Board is required by VR 689-14-01 Section 7.2(B) to adopt changes or modifications to the federal regulations or undertake a rulemaking to adopt more stringent control. Whether the Board eventually adopts the federal pretreatment standards for explosive manufacturing or adopts more stringent regulations, the treated red water, at a minimum, must meet the limitations established in 40 CFR §457.12 after the application of the best practical control technology currently available.

The federal Effluent Guidelines and Standards for explosives manufacturing are listed in 40 CFR 401 and 40 CFR 457, Subpart A. One of the primary discharge criteria is chemical oxygen demand (COD); the 1-day maximum discharge standard in 40 CFR 457, Subpart A is 7.77 pounds per 1,000 pounds of product. Thus, this standard is based on the rate of TNT production. Information on TNT production from *Evaluation of Six Options for Obtaining Red Water* (IT, April 1993) indicates that a COD standard based on concentration would be a maximum 1-day limit of 11,212 milligrams per liter (mg/L) and a 30-day average of below 3,694 mg/L.

Other discharges prohibited by VR 680-14-01 Section 7.4 include the introduction of pollutants into a POTW that will:

- Pass through or interfere with the operation or performance of the POTW
- Create a fire or explosive hazard in the POTW.
- Cause corrosive structural damage to the POTW
- Cause obstruction to the flow in the POTW
- Cause interference with the POTW (including oxygen demand)
- Result in inhibition of biological activity at the POTW due to heat.

The POTW is required by Section 7.4(B) of VR 680-14-01 to develop and enforce specific limits upon the industrial user.

3.2.3 Surface Water Discharge of Treated Red Water

The discharge of treated red water to surface water subjects it to regulation under Section 402 of the CWA. The discharge of treated waste to surface water must be authorized by a NPDES permit per 40 CFR 401, or the Commonwealth of Virginia equivalent (VPDES) per VR 680-14-01, if the facility is in Virginia. Permit limitations are established on a facility-specific basis to insure compliance with technology-based standards. The discharge of delisted treated red water to surface water in Virginia will be subject to the Virginia Water Quality Standards (VR 680-21-01).

3.3 Disposal Options and Regulatory Requirements for Circulating Bed Combustion Residues

Ash generated from the combustion of RCRA-listed (K047) red water will be classified as a K047 waste as defined by the "derived from rule." In addition to the K047 listing, the generator must also determine if the ash is a RCRA characteristic waste per 40 CFR 261, Subpart C. The RCRA characteristics include ignitability (D001), corrosivity (D002), reactivity (D003), and toxicity characteristic (D004-D043). The regulatory limits for these classifications are listed in 40 CFR 261, Subpart C. The ash can be landfilled as a hazardous waste in a RCRA-permitted hazardous waste landfill provided it meets the treatment standards in 40 CFR 268. If the ash has been delisted, it can be disposed in a nonhazardous waste (Subtitle D) landfill.

3.3.1 Disposal of Residue at a TSDF

One option for the final disposition of the K047 ash is disposal as a hazardous waste in a hazardous waste landfill (Subtitle C). Prior to land disposal, the ash must meet the land disposal restrictions in 40 CFR 268 for a K047 waste, any applicable RCRA characteristics, and the permit requirements of the TSDF. The land disposal restrictions for K047 as listed in 40 CFR 268.42 require deactivation to remove the hazardous characteristic of reactivity from the ash. This is a technology-based standard and does not specify a concentration limit.

Unless delisted, the ash must also be shipped as a hazardous waste. The generator must comply with the RCRA hazardous waste manifesting requirements (40 CFR 262) and DOT

(49 CFR 171 to 199) hazardous materials shipping requirements. The discussion of TSDF disposal requirements previously presented for WAO in Section 3.2 are applicable to CBC and not repeated.

3.3.2 Landfill Disposal of Residue

The second option for disposal of treated ash involves disposal in a nonhazardous waste landfill (Subtitle D). Prior to disposal in a nonhazardous landfill, the ash generated from the CBC process must be excluded from regulation by RCRA (delisted) by following the procedures described in 40 CFR 260.20 and 260.22. The delisting process requires the generator to demonstrate that the constituents for which the waste was listed and any other hazardous constituents (40 CFR 261, Appendix VIII) are not present in the waste at levels of regulatory concern and that the waste does not exhibit any of the characteristics of hazardous waste (i.e., ignitable, corrosive, reactive, or toxicity characteristics). To demonstrate the nonhazardous nature of the treated waste, the generator must include in the delisting petition to EPA additional information, as outlined in *Petitions to Delist Hazardous Waste A Guidance Manual* (Second Edition), EPA Office of Solid Waste, EPA 530-R-43-007, March 1993, to show that the waste will not be hazardous for other reasons. EPA evaluates the petition by using an analytical approach involving the modeling of the transport of toxic constituents from a landfill. The RCRA delisting process may take 18 to 24 months to complete and is cost effective only if significant volumes of waste are produced. It is anticipated that delisting will not be a viable option.

3.4 Air Emissions

3.4.1 Potential Emissions

Potential emissions from the CBC have been estimated, and are presented in Table 1, based on the material balance contained in the November 1994 IT report *TNT Red Water Incineration Pilot Plant Conceptual Design and Related Documents*. Emissions from the WAO are anticipated to be equivalent or lower.

3.4.2 Overview of Air Regulations

State and federal air pollution control regulations under both the RCRA and CAA programs are potentially applicable to the CBC, and to a lesser degree, to the WAO. The CBC will generate

Table 1

Preliminary Estimate of Air Emissions
CBC Pilot Incinerator[a]

Parameter	Estimated Emission (lb/hr)	Estimate Emission (ton/yr)
Carbon Dioxide	584	2,558
Carbon Monoxide	0.037	0.16
Oxygen	397	1,739
Nitrogen	3,851	16,867
Water	2,707	11,857
Particulate	0.6	2.6
Lead	NA	NA
Chromium	0.004	0.018
Nitrogen Oxides	12.78	56
Sodium sulfate of 2,4,5-TNT	0.0028	0.01
TNT-sellite complex	0.002	0.009
Sodium sulfonate of 2,3,4-TNT	0.0009	0.04
Sodium sulfonate of 2,3,5-TNT	0.0002	0.0009
2,4,6-Trinitrobenzoic acid (TNBA)	0.0001	0.0004
Trinitrobenzaldehyde (TNBAL)	0.001	0.0044
Trinitrobenzylalcohol (TNBOH)	0.001	0.0044
Ozone (as organics - propane)	0.089	0.39

[a]Based on operation 8760 hours a year.

Note: A 3-month test program with a 50 percent operating factor (common for a pilot-testing program) would give 1,080 hours of operation, for 6 to 9 tpy of NO_x, which is below the 10 tpy PSD exemption.

combustion byproducts that will be vented to the atmosphere through a stack after being treated through air pollution control equipment to remove regulated pollutants. Because the CBC is classified as an incinerator and red water is a RCRA listed waste, the CBC must be permitted as a RCRA hazardous waste incinerator and comply with RCRA air emission criteria. It is anticipated that the CBC will be permitted as an RD&D facility. Requirements for a RCRA RD&D permit vary in each application and may not be as stringent as for a non-RD&D permitted facility. Pre-permitting conferences should be held with the regulators to define the extent to which the requirements for a RCRA permitted incinerator will apply.

RCRA incinerator regulations include both design standards and operational standards (including emission criteria that must be considered in the design). The CBC must also comply with state and possibly federal air pollution control regulations. If the unit is sited at a location where it can be considered a stand-alone emission source, the state will require an air construction permit before construction can begin. If the unit is considered part of a larger facility (e.g., an AAP), the unit could be subject to a Prevention of Significant Deterioration (PSD) preconstruction permit modification and/or a Title V operating permit.

The WAO will generate less total air emissions (including water vapor, carbon dioxide, nitrogen, oxygen, and other combustion byproducts) than the CBC, but will likely still require air permits. The reactions taking place in the WAO will generate off-gassing. The treated effluent receiving tank will also experience off-gassing and working/breathing losses. There are no WAO-specific RCRA requirements that pertain to air emissions. However, there are certain general fugitive emissions requirements that could be applicable if the WAO is permitted under the 40 CFR 264, Subpart X criteria. If the WAO unit is sited at a location where it can be considered a stand-alone emission source, the state will require an air construction permit and operating permit. If the unit is considered part of a larger facility (e.g., an AAP), the unit could require a PSD preconstruction permit modification and/or a Title V operating permit.

3.4.3 Clean Air Act-Based Emission Regulations

RAAP is a potential site for the proposed WAO/CBC demonstration. It is located in Virginia Air Quality Control Region (AQCR) 2. AQCR 2 is a Class II area with attainment status for all of the criteria pollutants. Federal and state air quality regulations (referenced relative to CAA Title) to be considered in constructing a new source of air pollution located in an attainment

area are listed in Table 2. If the demonstration facilities are located in a nonattainment area, state-specific requirements would apply.

The basis for determining whether the WAO or CBC processes are subject to CAA Title V, PSD, hazardous air pollutant (HAP), or enhanced monitoring regulations is their "potential to emit." Potential to emit is defined as the emission rate of pollutants from a source running at maximum capacity after control equipment and enforceable permit limitations have been taken into account. Determination for the applicability of National Emissions Standards for Hazardous Air Pollutants (NESHAP), HAP, and accidental release planning regulations is based on the pollutants involved. The nature of the process itself determines whether maximum achievable control technology (MACT), New Source Performance Standards (NSPS), or the Acid Rain Program apply.

Applicability of the different air regulatory programs may also differ based on what assumption is used for siting the demonstration facility. Two assumptions made for the purpose of this review are:

- The CBC or WAO will be considered a stand-alone source and permitted separately
- The CBC or WAO will be considered a part of a facility with additional emission sources.

Under the first assumption, the air permitting process is relatively straightforward. However, if the unit is considered a modification to an existing facility permit, applicability would depend on the overall facility's status, particularly with regard to whether the facility was considered a major source before or after the modification. It may be advantageous to discuss this point with the regulatory agency prior to preparing permit applications, as it would be advantageous to site the pilot facility such that it is considered a separate source. The applicability of each of the major air programs summarized in Table 2 are discussed more fully in the following text.

3.4.3.1 National Ambient Air Quality Standards (NAAQS)

NAAQS are target concentrations of the criteria pollutants in the atmosphere to be achieved throughout the country. The states may establish standards that are more stringent but may not

Table 2

Summary of Potential Applicability
State and Federal Air Pollution Regulatory Programs

(Page 1 of 2)

Regulatory Program	Applicable To	CBC Applicability	WAO Applicability
National Ambient Air Quality Standard (NAAQS) regulations under Title I	Air quality in geographic regions throughout the United States	Applicable from a general perspective	Applicable from a general perspective
National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations under Title I	Sources that emit one of the seven HAPs for which standards have been promulgated	NA	NA
Hazardous Air Pollutant (HAP) regulations under Title III	Sources that emit one or more of the 189 regulated Hazardous Air Pollutants above deminimus quantities	NA - Emissions expected to be below deminimus	NA[a] - Emissions expected to be below deminimus
Maximum Achievable Control Technology (MACT) under Title III	The 174 source categories that emit one or more of the 189 regulated (HAPs)	NA[a] - Emissions expected to be below deminimus	NA [a] - Emissions expected to be below deminimus
New Source Performance Standards (NSPS) under Title I	Sources belonging to a category that is regulated under Title I	NA - Incinerators are NSPS only if > 50 tons/24 hr	NA
Accidental Release Planning and Residual Risk under Section 112(r) of the CAA	Facilities that store designated hazardous and flammable substances above threshold quantities	NA[a]	NA[a]
Prevention of Significant Deterioration (PSD) program under Title I	New major sources or modifications located in attainment areas. The definition of "major" source is different for the Title V and PSD programs. The applicable definitions are discussed in the respective sections.	NA[a] - Emissions of criteria pollutants not above deminimus 250 tpy	NA[a] - Emissions of criteria pollutants not above deminimus 250 tpy.

Table 2

(Page 2 of 2)

Regulatory Program	Applicable To	CBC Applicability	WAO Applicability
Operating Permit Program under Title V (Reflected in Part VII of the Virginia Air Regulations)	All major sources or modifications located in attainment areas.	NA[a]	NA[a]
Enhanced Monitoring Requirements under 40 CFR 64	Major sources of criteria pollutants	NA	NA
Acid Rain Program under Title IV	Power plants and other coal burning sources	NA	NA
Commonwealth of Virginia Regulations for the Control and Abatement of Air Pollution	Sources operating in the Commonwealth of Virginia	Applicable	Applicable
Commonwealth of Virginia Construction and Operating Permit Programs	Sources not covered included in a Title V permit.	Applicable	Applicable
State Air Toxics Program	Sources cannot emit over deminimus thresholds	Applicable	Applicable

[a]This program could be applicable if the WAO or CBC unit is permitted as a part of the overall facility, and not as a stand-alone facility.
NA - Not applicable.

allow air quality to deteriorate if pollution levels are already lower than prescribed by the NAAQS. Two levels to the NAAQS have been defined: primary and secondary. Primary air quality standards are those necessary, allowing for an adequate safety margin, to protect the public health. Secondary air quality standards are those designed to protect the public welfare from any known or anticipated adverse effects of a pollutant. These requirements are generally applicable to either the WAO or the CBC. Specific implementation criteria are discussed in Section 3.4.3.5 (PSD review).

3.4.3.2 National Emission Standards for Hazardous Air Pollutants (NESHAP)

The NESHAP program was originally established by the 1970 CAA Amendments to give EPA the authority to regulate pollutants not covered by the NAAQS. To date, only seven HAPs (asbestos, benzene, beryllium, inorganic arsenic, mercury, radionuclides, and vinyl chloride) have standards. Based on knowledge of process these requirements should not be applicable to the CBC or the WAO demonstrations.

3.4.3.3 Hazardous Air Pollutants (HAP)

As part of the 1990 CAA Amendments, EPA was required to establish emission standards for HAPs. One hundred and eighty-nine HAPs to be regulated have been identified. The emission standards will be established based on MACT, which reflects the maximum achievable degree of emission reduction after accounting for economic, environmental, and energy impacts. EPA is required to identify source categories and establish emission standards for sources in those categories that emit one or more of the 189 regulated HAPs. One hundred and seventy-four source categories have been identified and all must have emission standards by November 15, 2000. A certain percentage of these sources must have regulations established at intervals of 2, 4, 6, 7, and 10 years from the data of promulgation of the 1990 CAA (November 15, 1990). Priority is determined by several criteria:

- Effects of HAPs on public health and the environment
- Quality and location of emissions of HAPs
- Efficiency of grouping source categories by pollutants emitted or processes/technologies used.

The WAO and CBC processes would likely be classified as RCRA TSDFs requiring a RCRA Part B or RD&D Permit. Sources in this category were scheduled to have MACT regulations

promulgated by November 15, 1994, but have been delayed. These standards could not be evaluated for this report, but will likely be applicable at the time that demonstration is performed.

The HAP MACT requirements will not be applicable to the CBC or the WAO as stand-alone units because they are not considered major sources (emits more than 10 tons per year (tpy) of any one or more than 25 tpy of combined HAPs), based on preliminary emissions estimates. However, if combined as part of a group of stationary sources "within a contiguous area and under common control" (e.g., as part of the RAAP complex), the units could be subject to the MACT criteria as a major source.

3.4.3.4 New Source Performance Standards (NSPS)

NSPS have been established for particular industrial categories. Sources in one of these categories constructed or modified after the EPA proposes an applicable standard are subject to that standard. Virginia has adopted the federal NSPS as outlined in Part V of the state regulations. The only potentially applicable NSPS is that for incinerators (Subpart E). The standards are applicable to incinerators with charging rates greater than 50 tons per 24-hour period. The conceptual design capacity is approximately 10 tons per day (tpd), and therefore, this standard will not be applicable. It is anticipated that the WAO process will not be subject to any NSPS.

3.4.3.5 Prevention of Significant Deterioration (PSD)

The PSD program applies to major sources or modifications in attainment areas which have the potential to emit or increase pollutants emitted by "significant" amounts. In an attainment area, PSD could be triggered in two cases. First, if the facility currently represents a minor source (potential to emit less than 250 tpy for current activities), potential emissions from the WAO or CBC process considered alone must be greater than 250 tpy for PSD to apply. Second, if the facility currently represents a major source (potential to emit greater than 250 tpy for current activities), and the WAO/CBC process emission potential represents a major modification (any emission limit in Table 3 is exceeded), PSD applies.

If the PSD program is applicable, a permit must be obtained before construction of the new source can begin. The specific requirements of the PSD program are very detailed, but a brief

Table 3

Uncontrolled Emission Limits for Modification Permit Exemptions

Pollutant	Limit (tpy)
Carbon Monoxide	100
Nitrogen Dioxide	10
PM10	10
Sulfur Dioxide	10
Volatile Organic Compounds	10
Lead	0.6

synopsis is included in this section. To obtain a permit, a source must satisfy the following five requirements:

- Apply the Best Available Control Technology (BACT):
  - Identify all control technologies.
  - Perform a technical feasibility analysis.
  - Rank remaining control technologies by control effectiveness.
  - Evaluate the most effective controls and document results.-Select the BACT.
- Perform an Ambient Air Quality Analysis:
  - An ambient air quality analysis is required to ensure that new emissions do not violate the NAAQS or PSD increments. Pre- and post-construction monitoring is required, as well as meteorological monitoring.
- Analyze impacts to soil, vegetation, and visibility:
  - Direct and indirect impacts on soil, vegetation, and visibility must be addressed through analysis in the following four areas: growth due to the new source, ambient air quality, soils and vegetation, and visibility.
- Determine that air quality of Class I area is not adversely affected:
  - If a Class I attainment area is affected, the Federal Land Manager and the federal official charged with direct responsibility for managing the affected lands must be contacted. A review will be conducted with their input and could result in a PSD permit application being denied.
- Undergo adequate public participation:
  - Public notice requirements and a public comment period are required before a permit is granted.

If the pilot plant is permitted as a modification to a facility already considered a PSD major source, a PSD permit modification could be required, based on the preliminary emission estimate from Table 1. CBC emissions in Table 1 were estimated based on assuming a nitrogen concentration in the feed of 0.95 percent (conceptual design basis), and a 50 percent conversion (30 to 50 percent typical) of the organic bound nitrogen to NO_x (reported as NO_2). (See note in Table 1 regarding potential for lower NO_x emissions.) If the CBC unit is a stand-alone facility,

the PSD deminimus criterion (250 tpy) threshold should not be exceeded. The WAO unit should not be subject to the NO_x emission criteria, because NO_x emission are not anticipated to be significant.

3.4.3.6 Title V Operating Permit Program

Title V of the CAA Amendments of 1990 establishes a nationwide operating permit program for stationary sources of air pollution. Title V requires the states to develop federally enforceable operating permit programs. Virginia's permitting program is reflected in Part VIII of the Virginia Regulations for the Control and Abatement of Air Pollution.

A source is considered major under Title V in two cases. First, a source is major if it has the potential to emit greater than 100 tpy of any air pollutant. Second, a source is major if it has the potential to emit greater than or equal to 10 tpy of any HAP or greater than or equal to 25 tpy of two or more HAPs. If the test facility represents a major source under Title V and the CBC/WAO is permitted as part of that facility, construction and operating permits could be required under this program. If Title V is found to not be applicable, a Title V permit will not be necessary. However, a state construction and operation permit would likely be required.

3.4.3.7 Enhanced Monitoring Requirements

Major sources of criteria pollutants will be subject to federal requirements for enhanced monitoring. Continuous emission monitoring or an approved parametric monitoring plans are required for certain major sources and emission units that represent a specific fraction (30 percent as currently drafted) of a major source. This program will not be applicable to the CBC or the WAO demonstrations.

3.4.3.8 Acid Rain Program

Title V requires the permitting of power plant emissions as part of the Title IV Federal Acid Rain Program. This program does not apply to the red water technology demonstration.

3.4.3.9 Commonwealth of Virginia Permit Program

For any stationary source of air pollution operating in the state of Virginia, Part II of the Virginia air regulations regarding registration and reporting and Parts IV and V encompassing

process-specific emission standards and new and modified sources apply. The requirements can be subdivided into three categories:

- General provisions
- Emission standards
- Air toxics.

The WAO and the CBC processes would be subject to process-specific emission standards based on their respective modes of operation. WAO would probably be classified as a general process subject to emission standards in Virginia air regulations Part IV, Rule 4.4, Section 120-04-0403 and Sections 120-04-0405 to 0408. The CBC process would probably be classified as an incinerator subject to the emission standards in Virginia air regulations Part V, Section 120-05-0502, Subpart E (Part IV, Rule 4.7, Section 120-04-0703 does not apply as it is less restrictive). These key regulatory requirements are listed in Table 4.

A stationary source or operation that has the potential to emit toxic pollutants is prohibited from emission of quantities that would cause or contribute to any significant ambient air concentration (SAC) that may cause or contribute to the endangerment of human health. The SACs defined in the Virginia air regulation are specific fractions of the threshold limit value (TLV) for a substance over a prescribed averaging period. TLVs are established by the American Conference of Governmental Industrial Hygienists and refer to airborne concentrations of substances. The three categories of TLVs are as follows:

- TLV-C - Ceiling value
- TLV-STEL - Short-term exposure limit
- TLV-TWA - Time-weighted average.

A specific compound may have one, two, or all three of these values. Specific air toxics criteria are presented in Table 4.

3.4.4 RCRA-Based Air Emission Regulations

There are numerous air emission requirements under RCRA for an incinerator, but there are no specific requirements for a WAO unit. The Commonwealth of Virginia has established regulations governing waste incinerators under the Virginia hazardous waste rules of Section

Table 4

Summary of Key Virginia Air Pollution Control Regulations

Regulation	Requirement	CBC Applicability	WAO Applicability
120-02-05 Registration	Stationary sources must be registered with the State upon request if permit(s) are issued under Part VII or emission standards are given in Parts IV, V, or VI.	Yes	Yes
120-02-34 Facility and Control Equipment Maintenance or Malfunction	Any affected facility and its air pollution control or monitoring equipment must be operated and maintained using good air pollution control practices to the extent practicable. Requirements are given for bypassing or shutting down control equipment and for control equipment failures or malfunctions.	Yes	Yes
120-04-0403 Particulate Matter	Allowable particulate emissions are based on the feed rate to the process. A table of values is listed in the regulations, with an excerpt shown here: Process wt (lb/hr) — Maximum Allowable Emissions (lb/hr) 100 — 0.551 1000 — 2.58 10000 — 12.0 100000 — 69	No	Yes
120-04-0405 Sulfur Dioxide	Combustion Operation: $S=2.64 \times K$ $S=SO_2$ emissions (lb/hr) K=actual heat input at total capacity (BTU x 10^6/hr) Noncombustion Operation: The concentration of SO_2 in the stack must be less than 2,000 ppm by volume.	No	Yes
120-04-0406 Hydrogen Sulfide	H_2S emissions cannot be greater than 15 grains/1000 cubic feet of gas without removing or burning H_2S in excess of that concentration as long as SO_2 standards (120-04-0405) are maintained.	No	Yes
120-04-0407 VOC	Emissions are subject to Reasonably Available Control Technology	No	Yes
120-04-0408 NO_x	Emissions are subject to Reasonably Available Control Technology	No	Yes
120-05-0502 Particulate Matter	Emissions must be less than 0.08 grains/standard cubic foot of dry air corrected to 12 percent CO_2.	Yes	No

Table 4

(continued)

Regulation	Requirement	CBC Applicability	WAO Applicability
120-05-0104 (Rule 5-1) Visible Emission	Emissions at less than 20 percent opacity except for one 6-minute period in an hour during which opacity must be less than 30 percent.	Yes	Yes
120-05-0104 (Rule 5-1) Fugitive Dust/Emissions	Reasonable precautions must be taken to prevent airborne particulate matter during construction, modification, and operation.	Yes	Yes
120-05-0203 Odor	The Best Available Control Technology must be used to control odorous emissions.	Yes	Yes
120-05-0405 Standard for Major Stationary Sources	New major sources and major modifications located in PSD areas must not have emissions exceeding those resulting from using BACT. BACT is a standard of performance based on the maximum degree of emission reduction achievable through available processing and control systems or techniques as determined by the Board on a case-by-case basis after taking into account energy, environmental, and economic impacts and other costs.	Possibly	Not Likely
Air Toxics	Substance has TLV-C limit: Exempt emission rate[a] (lb/hr)= TLC-C (mg/m^3) x 0.033[a] Substance has TLV-STEL limit: Exempt emission rate[b] = TLV-STEL (mg/m^3) x 0.066 (lb/hr) TLV-STEL (mg/m^3) x 0.145 (ton/yr) Substance has only TLV-TWA: Exempt emission rate[b] = TLV-TWA (mg/m^3) x 0.066 (lb/hr) TLV-TWA (mg/m^3) x 0.145 (ton/yr) For toxic pollutants with no TLV, exemption will be determined by the State Air Pollution Control Board using available health effects information.	Yes	**Yes**

[a]Provided emissions do not exceed 22.8 lb/hr.
[b]Provided emissions do not exceed 22.8 lb/hr and 100 ton/yr.

10.14. This section includes requirements associated with air emissions. The Virginia regulations are similar to EPA regulations and can be summarized as follows:

- A destruction and removal efficiency (DRE) of 99.99 percent must be demonstrated for each principal organic hazardous constituent for an incinerator burning hazardous waste.

- A hydrogen chloride (HCl) stack emission rate must be no greater than the larger of either 4 pounds per hour or 1 percent of HCl generated.

- The particulate emission rate is less than 0.08 grains per dry standards cubic feet (dscf) (180 milligrams per dry standard cubic meter).

- The visible emission or opacity is less than 20 percent in the stack plume.

- The incinerator must be operated under a negative pressure or using an equivalent method to prevent fugitive emissions.

- The incinerator must be provided with an automatic waste feed cutoff system to immediately cut off waste feed if key permitted process conditions deviate from permit limits.

- Feed systems (i.e. piping, valves, pumps, etc.) containing organic compounds must be maintained, inspected (detailed inspection and recordkeeping requirements), and reported.

- A trial burn must be conducted soon after the unit is operational on RCRA waste to demonstrated performance standards and to establish process and feed limits that will be used to set final operating limits for the CBC unit.

In March 1993, EPA announced a new direction in incinerator permitting. EPA's draft combustion strategy called for a moratorium on any new capacity for 18 months, lower standards for dioxin and particulate emissions, a risk-based approach to establishing emission limits, and accelerated permitting of certain key facilities. This, combined with the EPA's "omnibus" authority under the 1984 RCRA amendments has provided EPA with considerable latitude to go above and beyond requirements found in the codified regulations when permitting hazardous waste facilities, particularly incinerators. The ramifications to this project are as follows:

- The more stringent EPA regulations from the Boiler and Industrial Furnace Regulations may be applied. These establish emission limits and routine waste analysis requirements for 10 metals including arsenic, antimony, barium, beryllium, cadmium, chromium, lead, mercury, silver, and thallium. These limits are risk-based, and application frequently requires that air dispersion models be used to predict ground level concentrations at worst-case receptors. Additionally, if the limits are not met assuming zero percent control, then the performance of the air pollution control system must be demonstrated at the maximum expected metals loading. With the low concentrations of metals (less than 10 parts per million [ppm]) anticipated in the waste stream, there should be no significant impact on operation based on use of a baghouse.

- The unit must be designed to remove dioxin to levels less than 30 nanograms per cubic meter (ng/m^3) total dioxins and furans. Based on recent EPA MACT evaluations, this level could be reduced to the 10 ng/m^3 level. Generally, an incinerator equipped with a baghouse, and operated outside the range of 450 to 750 degrees Fahrenheit (°F) should be able to achieve the 10 ng/m^3 limit. However, the mechanisms of dioxin formation are not well enough understood to provide definitive design criteria to ensure that lower limits can be achieved. In most cases, testing is performed soon after the unit is operational, and if problems are encountered, additional corrective measures are taken.

- The unit will be required to achieve a particulate removal efficiency of 0.015 grains/dscf. This is within the range of removal that can be achieved by a baghouse, but is much more stringent than the present 0.08 grains/dscf limit.

- There has been increased focus on products of incomplete combustion from incineration. EPA is currently requiring that incinerators speciate products of incomplete combustion (PIC) to the extent practical by testing soon after the unit is operational. The EPA has been using this information to conduct risk assessments.

- Revised RCRA incinerator regulations are anticipated to be published by late 1996. These will likely formally adopt the previously discussed requirements.

- A risk assessment could be required for the CBC based on emissions of metals, principal organic hazardous constituents (POHC), and PICs.

Because the demonstrations will be conducted at pilot-scale, and will likely be permitted under the RCRA RD&D provisions, the permitting agency is allowed considerable latitude in the permitting process. The extent to which the guidance and omnibus authority will be applied

will be determined by the agency personnel conducting the permit evaluation. Therefore, it is important that key agency personnel be informed as soon as possible as to the direction and approach to permitting the CBC.

4.0 Summary of Regulatory Actions for Red Water Treatment Technology Implementation

The anticipated requirements for the pilot-scale demonstration of red water treatment technologies and for full-scale implementation of a red water treatment technology are summarized below.

4.1 Pilot-Scale Demonstration Requirements

The regulatory actions required to perform pilot-scale demonstration include:

- Obtain/modify RCRA, CAA, and CWA operating permits.
- Determine RCRA classification of untreated waste.
- Determine DOT classification of untreated waste.
- Prepare waste and documents for proper shipping, including manifests, packaging, labeling, and placarding.
- Dispose of residues as required; residue disposal activities are similar to the residue disposal requirements outlined in Section 4.2.

4.2 Full-Scale Treatment System Implementation

The regulatory actions required for operation of the full scale treatment system include:

- Obtain or modify existing RCRA and CAA permits.
- For the discharge of treated water to surface water, obtain a NPDES/VPDES permit including a permit to install and a permit to operate a wastewater treatment system.
- For discharge to a POTW, obtain a discharge permit from the regulatory agency governing discharge to the POTW.
- For landfill of the ash as a nonhazardous waste, petition EPA for exclusion of the treated ash from 40 CFR 261. Obtain disposal approval from the landfill.

- For shipment of the WAO treated water to a TSDF or the CBC ash to a hazardous landfill, determine DOT hazardous material proper shipping name and shipping requirements. Obtain disposal approval from the TSDF or hazardous landfill. Prepare a hazardous waste manifest.

- Verify the compliance status of facilities used in the two previous bullet points.